TIMBER SUPPLY BRANCH

TIMBER SUPPLY REVIEW

Lakes Timber Supply Area Analysis Report and Information for Urgent Allowable Annual Cut (AAC) Increase

March 2001

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Lakes Timber Supply Area Analysis Report and Information for Urgent Allowable Annual Cut (AAC) Increase

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Preface

This report contains a timber supply analysis and a social-economic analysis and is part of the provincial Timber Supply Review carried out by the British Columbia Forest Service. The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) and tree farm licences (TFLs) throughout British Columbia. A review of each TSA and TFL is required every five years.

To determine allowable timber harvesting levels accurately and rationally, the chief forester must have an up-to-date assessment of the timber supply, based on the best available information and reflecting current management direction. **The report that follows provides this assessment but should not be construed as a recommendation on permissible harvest levels.**

This report focuses on a single forest management scenario — current management practices. Current management practices are defined by the specifications in management plans for the timber supply area including guidelines for the protection of forest resources, the *Forest Practices Code (FPC)* and official land-use decisions made by Cabinet.

Assessing the implications of only current practices rather than looking at a number of different management schemes will expedite the analysis process, allowing analysis of all TSAs in the province every five years. An important part of these analyses is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the assessment of the effects of current forest management on the timber supply form a solid basis for discussions among stakeholders about alternative timber harvesting levels.

In addition to having an up-to-date assessment of timber supply when setting the allowable annual cut (AAC) the chief forester considers short- and long-term implications of alternative harvest levels, capabilities and requirements of existing and proposed processing facilities, and the social and economic objectives of the Crown. The socio-economic analysis provides the chief forester with some of the information necessary for these considerations.

The socio-economic analysis considers forestry activity associated with the harvesting and processing of timber harvested from the TSA within the context of regional industry timber supply and production capacity.

This report is the third of five documents that will be released for each TSA as part of the Timber Supply Review. This document provides detailed technical information on the results of the timber supply and socio-economic analyses. A separate document called the public discussion paper will summarize the technical information regarding possible timber harvest levels and will provide a focus for public discussion. The fifth will outline the chief forester's harvest level decision and the reasoning behind it.

Executive Summary

As part of the provincial Timber Supply Review, the B.C. Forest Service has examined the availability of timber in the Lakes Timber Supply Area (TSA). The analysis makes an estimate of the available timber supply in both the short- and long-term, assuming the continuation of current forest management practices. It also examines the potential changes in timber supply stemming from uncertainties about forest inventory, forest growth and yield, and management actions. **It is important to note that the many forecasts included in the report are intended only to show the timber supply implications of current management practices and uncertainty and are not allowable annual cut (AAC) recommendations.** An allowable annual cut is determined by the chief forester after consideration of many factors, one of which is the results of this analysis.

The Lakes TSA covers a total of about 1.12 million hectares in north-central British Columbia. It extends from Babine Lake in the north to the Entiako River and the northeastern boundary of Tweedsmuir Park in the south. Within this area, approximately 745 000 hectares (66%) are productive forest managed by the Ministry of Forests. Of this productive forest, approximately 590 000 hectares (79%) are considered available for timber production and harvesting under current management practices. In the area available for timber harvesting, the greater part (450 567 hectares or 76%) of the forest is dominated by lodgepole pine in pure and mixed stands. Of that, 67% (302 077 hectares) is considered susceptible to attack by mountain pine beetle, which has been attacking significant areas in the southern portions of the TSA since 1995 and is spreading northward in the TSA

The allowable annual cut (AAC) for the Lakes TSA was last set in 1996 at 1.5 million cubic metres per year. Several woodlot licences have been created or expanded since then. Their AAC is removed from the AAC for the Lakes TSA, so the current AAC attributable to the TSA is 1.462 million cubic metres per year.

Six major changes from the previous analysis are included in this timber supply review:

- The *Forest Practices Code* is fully implemented, including management requirements for riparian areas, landscape-level biodiversity and stand-level biodiversity.
- The *Lakes Land and Resource Management Plan (LRMP)* was completed and approved in 2000. The *LRMP* includes management recommendations and new protected areas.
- A *Community Forest Pilot Agreement* was awarded, whose area is removed from the TSA because its AAC is set separately from the AAC of the TSA.
- A site productivity study for lodgepole pine in the Lakes, Morice and Vanderhoof TSAs showed that site productivity was underestimated in young managed pine stands.
- Lower minimum harvestable ages were adopted based on minimum harvestable volumes per hectare. This provides flexibility to harvest younger stands during the transition of harvesting from existing to regenerated stands.
- A critical issue analysis examines the mountain pine beetle epidemic.

The results of this timber supply analysis suggest that, without the mountain pine beetle epidemic, the current AAC attributable to the TSA can be maintained for 11 decades before increasing to a long-term harvest level of 1.695 million cubic metres per year. Compared with the 1995 analysis, the *Forest Practices Code*, the *LRMP* and the *Community Forest Pilot Agreement* act to decrease timber supply, while the results of the site productivity study and the lower minimum harvestable ages (MHA) act to increase timber supply. Overall, the increased productivity estimates and lower minimum harvestable ages outweigh the land removals and management requirements of the *Forest Practices Code*, the *LRMP* and removal of the *Community Forest Pilot Agreement*.

These results reflect current knowledge and information on forest inventory, growth and management. However, it is important to recognize that uncertainty exists about several factors important in defining timber supply. A series of sensitivity analyses showed that these uncertainties can affect timber supply to varying degrees. An alternative harvest flow suggests that the short-term timber supply could be increased immediately to the long-term harvest level without creating future disruptions in timber supply. This maximum non-declining harvest alternative is more sensitive, and more clearly quantifies the response to uncertainty in factors that affect timber supply, so it was used as the reference when conducting sensitivity analysis.

Executive Summary

The short-term (next 20 years) timber supply is most negatively affected by uncertainty in the size of the timber harvesting land base. Establishment of old-growth management areas has been identified as a source of unquantified reductions to the size of the timber harvesting land base. Completion of landscape unit planning by July 2002 will verify land base reductions for old-growth management areas. Uncertainty about the definition of problem forest types may result in a slight increase in the timber harvesting land base. Other factors, such as timber volume estimates for existing stands and increasing minimum harvestable ages by more than 20 years could have a negative effect, but there is no evidence to suggest that the estimates used for these factors are unreasonable. None of these factors reduce the short-term harvest level below the current AAC.

The medium-term (21-100 years) harvest level is most affected by uncertainties with the largest potential effects in the short term. Additionally, failure of pine stands to achieve the full site productivity potential could have negative effects in the medium term.

The long-term (beyond 100 years) harvest level is most affected by uncertainties in the size of the timber harvesting land base, timber volume estimates for regenerated stands, and site productivity estimates for pine. The effect of reductions in the size of the timber harvesting land base is the same as for the short term. There is no evidence to suggest that volume estimates for managed stands are unreasonable. However, reductions in timber volume estimates for regenerated pine stands could occur if the predicted increases in site productivity are not realized. This may be partially offset by higher volume estimates for regenerated spruce and fir/balsam stands due to possible increases in site productivity estimates for these stands.

Within the ranges of uncertainty tested, several factors were shown to have little to no effect (2% or less) on the maximum non-declining harvest forecast. These factors include changes to minimum harvestable ages up to 20 years, capping volume estimates for old stands, changing the maximum allowable disturbance for visual quality objectives (VQO), changes to green-up periods, changes in forest cover requirements to approximate adjacency constraints, the age at which stands achieve old-forest characteristics, and application of requirements for old-growth representation at the site series level.

A discrepancy was found in the disturbance limits for VQOs that were modelled for the base case, which produced a minor reduction in the long-term harvest level when corrected. Green-up ages may have been overestimated in the base case, which would have a small positive effect on timber supply. The assumptions about how stands age outside of the timber harvesting land base had a slightly larger potential impact of less than 4%, but did not affect the short-term harvest level.

A mountain pine beetle outbreak has expanded beyond what was originally predicted for the base case. This epidemic could expand to consume most of the susceptible pine (53 million cubic metres) over the next 10 years unless slowed by control measures or significantly affected by severe winter cold. A critical issue analysis examined several scenarios and tested several key assumptions related to the outbreak.

A worst case scenario was developed based on current rates of spread of the mountain pine beetle. This scenario assumed that the maximum amount of timber that could be harvested and absorbed by markets was 3.0 million cubic metres per year for 10 years. The worst case scenario harvest forecast has a decline of 35% per decade from an initial level of 3 million cubic metres per year to a medium-term harvest level of 1 270 000 cubic metres per year. The harvest forecast is affected by current gaps in the age class distribution that determine the medium-term harvest level, particularly in decades 7 and 8.

Effects of uncertainty in the size of the outbreak were tested by developing a moderate case scenario, which assumed a reduced rate of spread in the second 5-year period, and a best case scenario, which assumed that the outbreak would be stopped by a cold winter in 2001-2002. These scenarios show reduced medium-term impacts, with the best case scenario having no impact relative to the maximum non-declining forecast.

The implications of several uncertainties were tested with sensitivity analysis, including how long killed timber would remain merchantable and regeneration assumptions, and the ability of markets to absorb the higher quantities of harvested timber. If attacked timber will last for 10 years, mid-term impacts are greatly reduced. If attacked stands regenerate with a 5-year regeneration delay instead of a 10-year regeneration delay, then there is only a slight increase in the medium-term harvest level of 1%. If harvest levels cannot increase to 3.0 million cubic metres per year, then the medium-term harvest level will drop further compared with the worst case scenario.

Executive Summary

In conclusion, this analysis indicates that based on current inventory, growth and yield information, and the current management regime, timber harvests in the Lakes TSA could be maintained at the current level for at least 11 decades before rising to the long-term harvest level. Analysis suggested it would also be possible to increase the short-term harvest level immediately to the long-term level. The analysis indicates that several factors could affect timber supply. However, there is no evidence to suggest that short-term harvest levels are at risk.

A critical issue in this analysis is a major outbreak of mountain pine beetle. A worst case scenario, based on the current rate of spread, showed that the harvest level can be increased to 3.0 million cubic metres per year for 10 years, with little impact on the long-term harvest level. However, the medium-term harvest level could fall as low as 1 225 000 cubic metres per year, if it is not possible to harvest and process the increased volume of timber in the first decade. Medium-term supply remains higher if attacked timber remains merchantable for 10 years instead of becoming an immediate unsalvaged loss.

Table of Contents

PREFACE III

EXECUTIVE SUMMARY IV

INTRODUCTION 1

1 DESCRIPTION OF THE LAKES TIMBER SUPPLY AREA 4

1.1 The environment 4
1.2 First Nations 7

2 INFORMATION PREPARATION FOR THE TIMBER SUPPLY ANALYSIS 8

2.1 Land base inventory 8
2.2 Timber growth and yield 16
2.3 Management practices 16
2.4 Changes since the 1995 Lakes TSA timber supply analysis 22
2.4.1 Land base changes 22
2.4.2 Timber growth and yield changes 24
2.4.3 Forest management changes 25
2.4.4 Summary of changes 26

3 TIMBER SUPPLY ANALYSIS METHODS 27

4 RESULTS 28

4.1 Base case harvest forecast 28
4.2 Base case timber supply dynamics 31
4.3 Area, average volume and average age harvested 34
4.4 Age class distribution over time 36

5 TIMBER SUPPLY SENSITIVITY ANALYSES 38

5.1 Alternative harvest flows over time 38
5.2 Uncertainty in land base available for timber harvesting 40
5.3 Uncertainty in site productivity estimates for pine 42
5.4 Uncertainty in site productivity estimates for older spruce, fir and balsam stands 44
5.5 Sources of uncertainty with little or no sensitivity 46
5.6 Sources of uncertainty with low risk 48

6 CRITICAL ISSUE ANALYSIS — MOUNTAIN PINE BEETLE OUTBREAK 49

6.1 Description of mountain pine beetle outbreak 49
6.2 Harvest forecast for a worst case infestation 52
6.3 Implications of a worst case infestation 53
6.4 Uncertainty in size of the mountain pine beetle outbreak 59
6.5 Uncertainty in merchantability of attacked stands 60
6.6 Uncertainty in regeneration of attacked stands 62
6.7 Uncertainty in ability to salvage timber 62

7 SUMMARY AND CONCLUSIONS OF THE TIMBER SUPPLY ANALYSIS 64

7.1 Base case 64
7.2 Sensitivity analysis 64
7.3 Critical issue analysis — mountain pine beetle outbreak 67
7.4 Summary 68

Table of Contents

8 SOCIO-ECONOMIC ANALYSIS 69

8.1 CURRENT SOCIO-ECONOMIC SETTING 69
8.1.1 Overview 69
8.1.2 Population and demographic trends 69
8.1.3 Economic profile 69
8.2 LAKES TSA FOREST INDUSTRY 71
8.2.1 Current allowable annual cut 71
8.2.2 Lakes TSA harvest history 71
8.2.3 Lakes TSA major licensees 72
8.2.4 Forest sector employment summary 76
8.2.5 Lakes TSA employment income 77
8.2.6 Provincial government revenues 78
8.3 SOCIO-ECONOMIC IMPLICATIONS OF THE BASE CASE HARVEST FORECAST 78
8.3.1 Short- and long-term implications of alternative harvest levels 79
8.3.2 Community level impacts 81
8.3.4 Nature, production capabilities, and timber requirements of processing facilities 81
8.3.3 Regional timber supply implications 81
8.4 SUMMARY 81

9 REFERENCES 82

10 GLOSSARY 83

APPENDIX A DESCRIPTION OF DATA INPUTS AND ASSUMPTIONS FOR THE TIMBER SUPPLY ANALYSIS 91

INTRODUCTION 92

A.1 INVENTORY INFORMATION 93

A.2 ZONE AND ANALYSIS UNIT DEFINITIONS 95

A.3 DEFINITION OF THE TIMBER HARVESTING LAND BASE 97

A.4 CURRENT FOREST MANAGEMENT ASSUMPTIONS 103

A.5 VOLUME ESTIMATES FOR EXISTING STANDS 118

A.6 VOLUME ESTIMATES FOR REGENERATED STANDS 120

APPENDIX B SOCIO-ECONOMIC ANALYSIS BACKGROUND INFORMATION 123

B.1 LIMITATIONS OF ECONOMIC ANALYSIS 124

B.2 ECONOMIC IMPACT ANALYSIS METHODOLOGY 125

Table of Contents

Tables

TABLE 1. SPECIES AT RISK AS LISTED UNDER THE FOREST PRACTICES CODE INHABITING THE LAKES TSA 6

TABLE 2. DETERMINATION OF THE TIMBER HARVESTING LAND BASE FOR THE LAKES TSA 11

TABLE 3. AREA OF PRODUCTIVE FOREST BY BIOGEOCLIMATIC ECOSYSTEM VARIANT AND TIMBER HARVESTING LAND 21

TABLE 4. COMPARISON OF THE TIMBER HARVESTING LAND BASE FOR THE LAKES TSA WITH THE 1995 ANALYSIS 24

TABLE 5. SITE PRODUCTIVITY ESTIMATES FOR PINE — LAKES TSA, 2001. 42

TABLE 6. SITE PRODUCTIVITY ESTIMATES FOR OLD SPRUCE AND FIR/BALSAM — LAKES TSA, 2001 44

TABLE 7. SUMMARY OF SENSITIVITY ANALYSES WITH LITTLE OR NO EFFECT ON THE MAXIMUM NON-DECLINING HARVEST FORECAST — LAKES TSA, 2001 47

TABLE 8. SUMMARY OF SENSITIVITY ANALYSES FOR FACTORS WITH LITTLE UNCERTAINTY — LAKES TSA, 2001 48

TABLE 9. TOTAL PINE VOLUMES ATTACKED AND UNSALVAGED FOR EACH MOUNTAIN PINE BEETLE OUTBREAK SCENARIO — LAKES TSA, 2001 60

TABLE 10. SUMMARY OF HARVEST FORECASTS FOR BASE CASE AND SENSITIVITY ANALYSES WITH SIGNIFICANT EFFECTS — LAKES TSA, 2001 66

TABLE 11. SUMMARY OF HARVEST FORECASTS FOR BASE CASE AND SENSITIVITY ANALYSES — LAKES TSA, 2001 67

TABLE 12. LAKES TSA ALLOWABLE ANNUAL CUT APPORTIONMENT, BY LICENCE TYPE 71

TABLE 13. LAKES TSA VOLUMES BILLED, BY LICENCE TYPE, 1997-2000 72

TABLE 14. BABINE FOREST PRODUCTS HARVEST AND DIRECT EMPLOYMENT STATISTICS 73

TABLE 15. BABINE TIMBER HARVEST AND DIRECT EMPLOYMENT STATISTICS 73

TABLE 16 WEST FRASER MILLS LTD. HARVEST AND DIRECT EMPLOYMENT STATISTICS 74

TABLE 17 RUSTAD BROS. & CO. LTD. HARVEST AND DIRECT EMPLOYMENT STATISTICS 74

TABLE 18 L&M LUMBER LTD. HARVEST AND DIRECT EMPLOYMENT STATISTICS 75

TABLE 19 LAKES TSA EMPLOYMENT AND EMPLOYMENT COEFFICIENTS 77

TABLE 20. AVERAGE ANNUAL DIRECT AND INDIRECT/INDUCED INCOMES AND TOTAL EMPLOYMENT INCOME, 1997-1999 77

TABLE 21. AVERAGE ANNUAL PROVINCIAL GOVERNMENT REVENUES, 1997- 2000 78

TABLE 22. SOCIO-ECONOMIC IMPACTS OF THE LAKES TSA BASE CASE FORECAST 80

TABLE A-1. INVENTORY INFORMATION 93

TABLE A-2. OBJECTIVES TO BE TRACKED 95

TABLE A-3. DEFINITION OF ANALYSIS UNITS 96

TABLE A-4. DESCRIPTION OF ENVIRONMENTALLY SENSITIVE AREAS 98

TABLE A-5. DESCRIPTION OF INOPERABLE AREAS 99

TABLE A-6. DESCRIPTION OF SITES WITH LOW TIMBER GROWING POTENTIAL 99

TABLE A-7. PROBLEM FOREST TYPES CRITERIA 100

TABLE A-8. ESTIMATES FOR EXISTING AND FUTURE ROADS, TRAILS, AND LANDINGS 101

TABLE A-9. UTILIZATION LEVELS 103

TABLE A-10A. MINIMUM HARVESTABLE AGES 104

TABLE A-10B. MINIMUM HARVESTABLE AGES FOR REGENERATED PINE STANDS WITH A SITE INDEX ADJUSTMENT 105

TABLE A-11. PRIORITIES FOR SCHEDULING HARVESTS 106

TABLE A-12. UNSALVAGED LOSSES 107

Table of Contents

Tables (continued)

TABLE A-13A. REGENERATION ASSUMPTIONS BY ANALYSIS UNIT 108

TABLE A-13B. SITE INDEX FOR REGENERATED ANALYSIS UNITS 110

TABLE A-14. IMMATURE PLANTATION HISTORY 111

TABLE A-15. NOT SATISFACTORILY RESTOCKED (NSR) AREAS 112

TABLE A-16A. FOREST COVER REQUIREMENTS — VQOS AND HABITAT 113

TABLE A-16B. CALCULATION OF MAXIMUM ALLOWABLE DISTURBANCE IN VQOS 114

TABLE A-17A. SERAL STAGE REQUIREMENTS BY BIOGEOCLIMATIC VARIANT. 115

TABLE A-17B. DRAFT BIODIVERSITY EMPHASIS OPTIONS BY DRAFT LANDSCAPE UNIT 116

TABLE A-18. VOLUME REDUCTIONS TO REFLECT RETENTION OF WILDLIFE TREE PATCHES IN CUTBLOCKS 116

TABLE A-19. TIMBER VOLUME TABLES FOR EXISTING NATURAL STANDS (CUBIC METRES PER HECTARE) 118

TABLE A-20. TIMBER VOLUME TABLES FOR MANAGED STANDS (CUBIC METRES PER HECTARE) 120

TABLE B-1. EMPLOYMENT MULTIPLIERS — LAKES TSA 127

TABLE B-2. ESTIMATES OF PROVINCIAL GOVERNMENT REVENUES — LAKES TSA 128

Table of Contents

Figures

FIGURE 1. MAP OF THE LAKES TIMBER SUPPLY AREA, PRINCE RUPERT FOREST REGION. 5

FIGURE 2. AREA BY TREE SPECIES GROUP RELATIVE TO MINIMUM HARVESTABLE AGE — LAKES TSA TIMBER HARVESTING LAND BASE, 2001. 12

FIGURE 3. AREA BY TREE SPECIES GROUP AND TIMBER PRODUCTIVITY — LAKES TSA TIMBER HARVESTING LAND BASE, 2001. 13

FIGURE 4. AREA BY SPECIES AND AGE GROUP — LAKES TSA TIMBER HARVESTING LAND BASE, 2001. 14

FIGURE 5. CURRENT AGE CLASS DISTRIBUTION — LAKES TSA PRODUCTIVE FOREST LAND BASE, 2001. 15

FIGURE 6. AREA BY MANAGEMENT EMPHASIS — LAKES TSA TIMBER HARVESTING LAND BASE, 2001 20

FIGURE 7. CURRENT AND 1995 BASE CASE HARVEST FORECASTS — LAKES TSA, 2001 29

FIGURE 8. HARVEST CONTRIBUTIONS FROM MANAGED STANDS — LAKES TSA BASE CASE HARVEST FORECAST, 2001 31

FIGURE 9. HARVEST CONTRIBUTION BY MANAGEMENT EMPHASIS — LAKES TSA BASE CASE HARVEST FORECAST, 2001. 32

FIGURE 10. TIMBER GROWING STOCK FORECASTS — LAKES TSA BASE CASE HARVEST FORECAST, 2001. 33

FIGURE 11. AVERAGE VOLUME YIELD AND AVERAGE ANNUAL AREA HARVESTED — LAKES TSA BASE CASE HARVEST FORECAST, 2001. 34

FIGURE 12. AVERAGE AREA-WEIGHTED HARVEST AGE — LAKES TSA BASE CASE HARVEST FORECAST, 2001. 35

FIGURE 13. DISTRIBUTION OF AGE CLASSES FOR THE PRODUCTIVE FOREST AREA AT 50 YEAR INTERVALS — LAKES TSA BASE CASE HARVEST FORECAST, 2001 37

FIGURE 14. ALTERNATIVE HARVEST FLOW USING BASE CASE DATA — LAKES TSA, 2001. 39

FIGURE 15. SENSITIVITY ANALYSIS OF TIMBER HARVESTING LAND BASE SIZE — LAKES TSA, 2001 40

FIGURE 16. SENSITIVITY ANALYSIS OF SITE PRODUCTIVITY OF PINE STANDS — LAKES TSA, 2001. 43

FIGURE 17. SENSITIVITY ANALYSIS OF SITE PRODUCTIVITY ESTIMATES IN OLDER SPRUCE, FIR AND BALSAM STANDS — LAKES TSA, 2001. 45

FIGURE 18. INFESTATION LEVELS FOR MOUNTAIN PINE BEETLE FOR 2001 AND PROJECTED FOR WORST CASE IN 2010 — LAKES TSA, 2001. 51

FIGURE 19. HARVEST FORECAST FOR WORST CASE SCENARIO OF MOUNTAIN PINE BEETLE OUTBREAK — LAKES TSA, 2001 52

FIGURE 20. HARVEST CONTRIBUTIONS FROM MANAGED STANDS FOR THE WORST CASE MOUNTAIN PINE BEETLE SCENARIO — LAKES TSA, 2001 53

FIGURE 21. TIMBER GROWING STOCK FORECASTS FOR THE WORST CASE MOUNTAIN PINE BEETLE SCENARIO — LAKES TSA, 2001. 54

FIGURE 22. AVERAGE VOLUME YIELD AND AVERAGE ANNUAL AREA HARVESTED FOR THE WORST CASE MOUNTAIN PINE BEETLE SCENARIO — LAKES TSA, 2001. 55

FIGURE 23. AVERAGE AREA-WEIGHTED HARVEST AGE FOR THE WORST CASE MOUNTAIN PINE BEETLE SCENARIO — LAKES TSA, 2001. 56

FIGURE 24. DISTRIBUTION OF AGE CLASSES FOR THE PRODUCTIVE FOREST AREA AT 50 YEAR INTERVALS FOR THE WORST CASE MOUNTAIN PINE BEETLE SCENARIO — LAKES TSA, 2001 58

FIGURE 25 SENSITIVITY ANALYSIS OF UNCERTAINTY IN SIZE OF MOUNTAIN PINE BEETLE OUTBREAK — LAKES TSA, 2001. 59

FIGURE 26. SENSITIVITY ANALYSIS OF UNCERTAINTY IN MERCHANTABILITY OF ATTACKED STANDS FOR THE WORST CASE MOUNTAIN PINE BEETLE SCENARIO — LAKES TSA, 2001 61

FIGURE 27. SENSITIVITY ANALYSIS OF NO ADDITIONAL SALVAGE FOR THE WORST CASE MOUNTAIN PINE BEETLE SCENARIO — LAKES TSA, 2001 63

FIGURE 28. TOTAL EMPLOYMENT BY BASIC SECTOR*, 1996. 70

Introduction

Timber supply* is the quantity of timber available for harvest over time. Timber supply is dynamic, not only because trees naturally grow and die, but also because conditions that affect tree growth, and the social and economic factors that affect the availability of trees for harvest, change through time.

Assessing the timber supply involves considering physical, biological, social and economic factors for all forest resource values, not just for timber. Physical factors include the land features of the area under study as well as the physical characteristics of living organisms, especially trees. Biological factors include the growth and development of living organisms. Economic factors include the financial profitability of conducting forest operations, and the broader community and social aspects of managing the forest resource.

All of these factors are linked: the financial profitability of harvest operations depends upon the terrain, as well as the physical characteristics of the trees to be harvested. Determining the physical characteristics of trees in the future requires knowledge of their growth. Decisions about whether a stand is available for harvest often depend on how its harvest could affect the growth and development of another part of the forest resource, such as wildlife or a recreation area.

These factors are also subject to both uncertainty and different points of view. Financial profitability may change as world timber markets change. Unforeseen losses due to fire or pest infestations will alter the amount and value of timber. The appropriate balance of timber and non-timber values in a forest is an ongoing subject of debate, and is complicated by changes in social objectives over time.

Thus, before an estimate of timber supply is interpreted, the set of physical, biological and socio-economic conditions on which it is based, and which define current forest management — as well as the uncertainties affecting these conditions — must first be understood.

Timber supply analysis is the process of assessing and predicting the current and future timber supply for a management unit (a geographic area). For a timber supply area (TSA)*, the timber supply analysis forms part of the information used by the chief forester of British Columbia in determining an allowable annual cut (AAC)* — the permissible harvest level for the area.

Timber supply projections made for TSAs look far into the future — 250 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. Indeed, the *Forest Act* requires that the timber supply for management units throughout British Columbia be reviewed at least every 5 years. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

**Throughout this document, an asterisk after a word or phrase indicates that it is defined in a box at the foot of the page, as well as in the glossary.*

Timber supply
The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)
An integrated resource management unit established in accordance with Section 7 of the Forest Act.

Allowable annual cut (AAC)
The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

Introduction

Timber supply analysis involves three main steps. The first is collecting and preparing information and data. The B.C. Forest Service forest inventory* plays a major role in this. The second step is using this data along with a timber supply computer model or models* to make projections or estimates of possible harvest levels over time. These projections are made using different sets of assumed values or conditions for the factors discussed above. The third step is interpreting and reporting results.

The following sections outline the timber supply analysis for the Lakes TSA. Following a brief description of the area in Section 1, data preparation and formulation of assumptions are discussed in Section 2. Analysis methodology and results are presented in Sections 3 and 4. Section 5 examines the sensitivity of the results to uncertainties in the data and assumptions used. Section 6 examines the impact on timber supply of critical issues, in this case, a significant mountain pine beetle outbreak. This is followed by a summary and conclusions.

Appendix A contains further details about the data and assumptions used in this analysis.

As part of the timber supply review, information is gathered on the short- and long-term implications of alternative harvest levels, and the capabilities and requirements of existing and proposed processing facilities. The socio-economic analysis (SEA), presented in Section 8, provides information for the chief forester and the local community to better understand the potential magnitude of impacts associated with any proposed harvest level changes.

The socio-economic analysis considers the current and projected levels of forestry activity associated with the Lakes TSA within the context of regional timber supplies and production capacity. It does this by examining the profile of the region and the local forest industry; and by undertaking a socio-economic analysis using the harvest forecasts* as projected in the base case and in the mountain pine beetle analysis.

The socio-economic analysis includes an estimate of the employment and income impacts associated with timber supply analysis projections by three main sectors: harvesting and other woodlands-related, processing, and silviculture. Employment is measured in terms of person-years*. Employment income is calculated using average industry income estimates.

Data on direct employment, harvest levels, and fibre flows was obtained by surveying licensees and mill operators. The information was used to estimate harvesting, processing and silviculture direct employment averages associated with the harvest, and the proportion of workers living in the area. The estimates of local and provincial harvesting, processing, and silviculture direct employment were then used to determine ratios of employment per 1000 cubic metres of timber harvested.

Forest inventory
An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Model
An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.

Harvest forecast
The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

Person-year(s)
One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.

Introduction

Indirect and induced employment figures were calculated using the Lakes TSA and provincial employment multipliers* developed by the Ministry of Finance and Corporate Relations. Indirect impacts result from direct businesses purchasing goods and services; induced impacts result from direct employees purchasing goods and services. Employment coefficients* per 1000 cubic metres were also determined for the indirect and induced impacts.

To estimate the level of employment that could be supported by alternative harvest rates, projected timber supply levels were multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on current productivity, harvest practices and management assumptions* and will not likely reflect industry conditions decades into the future. As such, the employment estimates can only be viewed as general indicators.

Employment multiplier
An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

Employment coefficient
The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

Management assumptions
Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

1 Description of the Lakes Timber Supply Area

The Lakes Timber Supply Area (TSA), located in central British Columbia, covers approximately 1.12 million hectares of the Lakes Forest District, one of six districts in the Prince Rupert Forest Region. The Lakes TSA is administered by the forest district office in Burns Lake.

The Lakes TSA occupies the easternmost portion of the Prince Rupert Forest Region, extending from Babine Lake in the north to the Entiako River in the south. The TSA lies along the western edge of B.C.'s interior plateau and is characterized by gently rolling uplands and a high concentration of lakes. Almost 10% of the TSA is classified as lake and three major lake systems intersect the TSA in an east-west direction (Babine, Francois and Ootsa). The northeast portion of Tweedsmuir Provincial Park is adjacent to the southern part of the TSA.

Approximately 66% of the TSA land base is considered Crown productive forest land (approximately 745 000 hectares). Currently about 79% of that productive forest is considered suitable and available for timber harvesting, representing about 52% of the total TSA land base. The current allowable annual cut (AAC) of 1.5 million cubic metres was set in 1982, and reconfirmed in 1987 and 1996. The AAC is apportioned by the Minister of Forests to various licences, including forest licences, the Small Business Forest Enterprise Program (SBFEP) and the woodlot program.

The forests of the Lakes TSA are relatively homogeneous. Lodgepole pine stands, both pure and mixed with other species, dominate the TSA, representing about 76% of stands within the timber harvesting land base*. Spruce-leading stands cover about 20% and balsam- and fir-leading stands about 4% of the harvesting land base.

Significant changes in forest management legislation and policy have occurred since the last timber supply review was completed. These include implementation of the *Forest Practices Code (FPC)**; government approval in April 2000 of the *Lakes Land and Resource Management Plan (LRMP)**, which creates new protected areas* and provides guidance on forest practices for the Lakes TSA; and the awarding of a *Community Forest Pilot Agreement* to Burns Lake Community Forest Ltd.

The Lakes TSA is a sparsely populated area with many small rural communities. The major population centre is the Village of Burns Lake, where about one-third of the TSA's population of 6,900 (1996 census) reside. Other communities include Decker Lake, Tintegal, Francois Lake, Southbank, Grassy Plains, Danskin, Takysie Lake and Ootsa Lake.

The forests of the Lakes TSA provide for a wide range of resources, including forest products, fish and wildlife habitat, and recreation and tourism amenities. Recreational use of the forests is moderately high due to the proximity of Tweedsmuir Provincial Park and the high concentration of lakes in the TSA. Recreational activities are primarily fishing, boating and hunting. Visual quality is an important value for recreation and tourism.

1.1 The environment

Three biogeoclimatic zones* are found in the Lakes TSA. The dominant zone in this TSA, and in the central interior of the province, is the Sub-Boreal Spruce (SBS) Zone. The SBS is found in valley bottoms up to about 1300 metres, and its climate is characterized by moderate annual precipitation, severe, snowy winters and relatively warm, moist and short summers. Lodgepole pine, hybrid white spruce and subalpine fir are the dominant tree species.

Timber harvesting land base
Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.

Forest Practices Code
Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

Land and Resource Management Plan (LRMP)
A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision making, and resource sustainability.

Protected area
A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).

Biogeoclimatic zones
A large geographic area with broadly homogeneous climate and similar dominant tree species.

1 Description of the Lakes Timber Supply Area

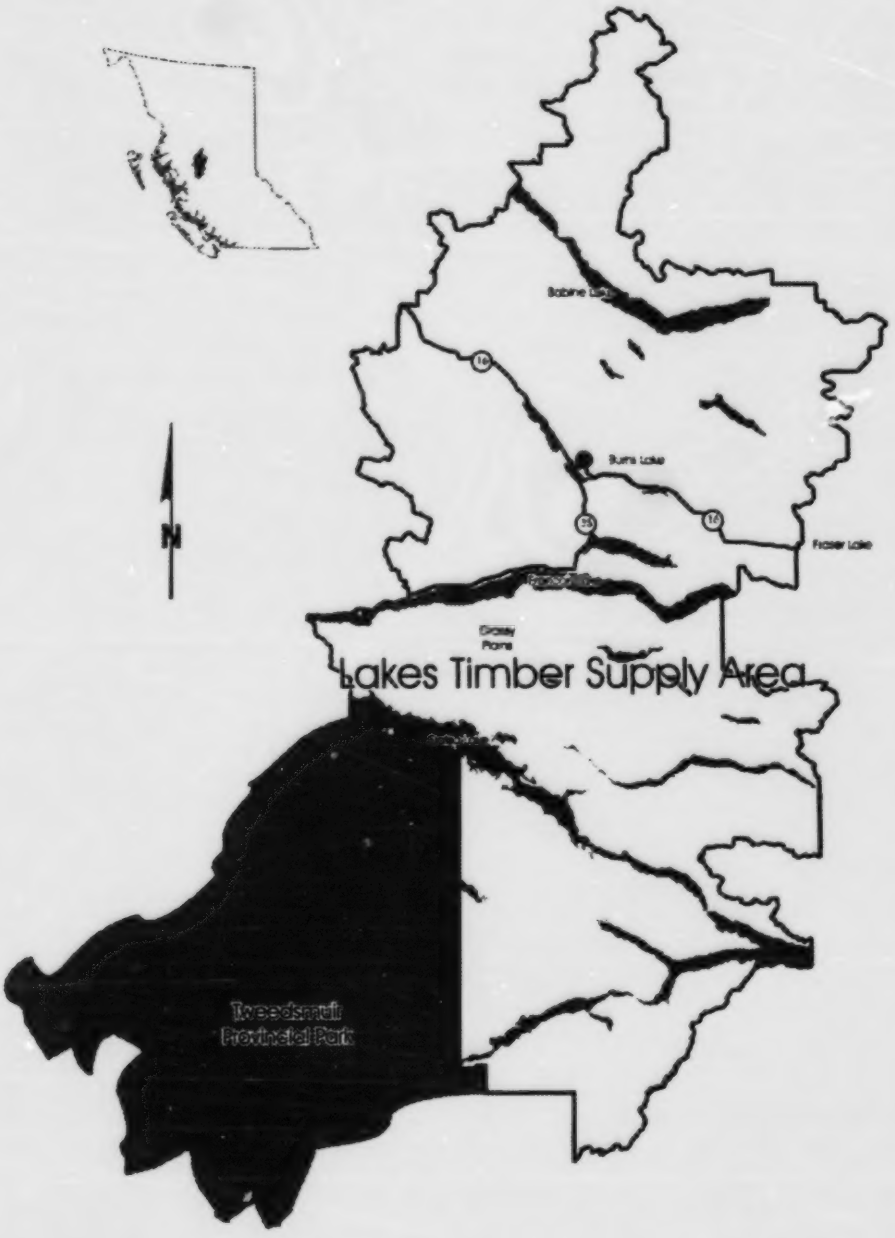

Figure 1. Map of the Lakes Timber Supply Area, Prince Rupert Forest Region.

1 Description of the Lakes Timber Supply Area

The Engelmann Spruce-Subalpine Fir (ESSF) zone is the uppermost forested zone in the Lakes TSA, typically occurring in pockets throughout the TSA, above the SBS zone. Steep topography, along with wet, cool summers and long, snowy winters, characterize this zone. Engelmann spruce and subalpine fir are the dominant climax tree species, while lodgepole pine is common after fires.

The Alpine Tundra (AT) zone occurs in very small areas above 1600 metres. The climate is cold, windy and snowy with a short, cool growing season. By definition this zone is treeless, although stunted trees are common at lower elevations of this zone. Vegetation is dominated by shrubs, herbs, mosses and lichens. Much of the alpine landscape lacks vegetation and is the domain of rock, ice and snow.

The forests of the Lakes TSA support a wide variety of wildlife species that are adapted to either surviving or avoiding the severe winters. These include moose, caribou, grizzly bear, mule deer, black bear and small furbearers. A number of special habitat management areas occur in the TSA, such as the caribou migration corridor from Chief Louis Lake to Tetachuck Lake; significant grizzly habitat areas in the Sutherland Valley and Klaytunkut Creek; and ungulate* winter habitat (for provincially important moose and the regionally and provincially significant Tweedsmuir-Entiako caribou herd).

Under the *Forest Practices Code*, a process exists for identifying species at risk and designating wildlife habitat areas with specific management practices. The wildlife species that have been declared Identified Wildlife in the five ecosections of the Lakes Forest District are presented in Table 1.

Table 1. Species at risk as listed under the Forest Practices Code inhabiting the Lakes TSA

Common names of identified wildlife	Kitimat Ranges	Bulkley Basin	Nazko Upland	Nechako Upland	Babine Upland
Bull trout	x	x	X	x	X
American bittern		x	X		X
Sandhill crane	x	x	X	x	X
Trumpeter swan		x			X
Northern goshawk *atricapillus*	x	x	X	x	X
Fisher	x	x	X	x	X
Grizzly bear	x	x	X	x	X
Mountain goat	x			x	

Source: *Managing Identified Wildlife: Procedures and Measures*, Volume 1, February 1999.

Protection of water resources is an important management objective in this TSA, particularly to protect fisheries values. Creeks, rivers and lakes throughout the TSA support both heavy sportsfishing and the native food fishery. Common fish species include sockeye salmon, pink salmon, burbot, lake trout, rainbow trout, whitefish, northern pike minnow and suckers. An issue of concern is increasing access to lakeshores, increasing the potential for overfishing, particularly of trout.

Ungulate
A hoofed herbivore, such as deer.

Current forest management practices follow the legislation and regulations set out by the *Forest Practices Code*. Consequently, the protection of wildlife and the environment will be managed through the *Code*. As well, the implementation of the *Lakes LRMP* provides additional strategies and guidance for forest practices.

1.2 First Nations

Six First Nations have reserve lands and communities in the Lakes TSA, with a total population of about 2,500 persons. These First Nations are the Cheslatta Carrier Nation, Burns Lake Band, Nee Tahi Buhn Band, Skin Tyee Band, Wet'suwet'en First Nation and Lake Babine Nation. These local First Nations and six others claim traditional territory that overlap within the Lakes TSA. Several First Nations, both local and non-local, are negotiating comprehensive land claims within the TSA. Once the treaty processes are complete, the treaties will be considered in future timber supply reviews.

The forest industry is the major employer of First Nations people in the Lakes TSA, providing employment in harvesting, silviculture and sawmilling. The six local First Nations are members of the Burns Lake Native Development Corporation, which provides employment in administration, harvesting and silviculture. The corporation has a 15% ownership interest in Babine Forest Products Ltd. which in turn has interests in three manufacturing facilities (Babine Forest Products Co., Decker Lake Forest Products and Burns Lake Specialty Wood).

First Nations have expressed concerns about forestry activities in areas with high cultural values. The Lakes Forest District has developed the *Lakes Archaeological Resource Project (LARP)*, which utilizes maps and an extensive archaeological and historical database to identify cultural sites. The *LARP* project considered information from First Nations, traditional use studies, archaeological impact assessments (AIA), culturally modified tree* inventories, archival sources and settlers. Archaeological overview assessments (AOA) have been completed for the TSA based on the *LARP* information. By using the information gathered by the project, assessments, inventories and consultation, the Lakes Forest District is able to consider cultural values during operational planning activities. This information was assessed in developing information for this analysis (see Appendix A, Section A.3.9, Cultural heritage resources).

Culturally modified tree
A tree or a remnant of a tree with evidence of traditional aboriginal forest use.

2 Information Preparation for the Timber Supply Analysis

Much information is required for timber supply analysis. This information falls into three general categories: land base inventory; timber growth and yield; and management practices.

2.1 Land base inventory

Land base information used in this analysis came in the form of a computer file compiled in 1998 by the B.C. Forest Service. This file contains a considerable amount of information on the forest land in the Lakes TSA including general geographic location, area, nature of forest cover (such as presence or absence of trees, species, number of trees, age, and timber volume), and other notable characteristics such as environmental sensitivity and physical accessibility (operability*). Stand characteristics such as tree height, stocking* and age have been projected to January 1998. Except for a few mapsheets shared with adjacent forest districts, the inventory file has been updated to account for timber harvesting up to December 1994 for the Lakes TSA.

The inventory file represents the land base for the entire TSA. It includes information on land that does not contain forest, and other areas where timber harvesting is not expected to occur. Examples are land set aside for parks, areas needed to protect wildlife habitat, and areas in power lines, highways, or town sites. A description of these areas specific to the Lakes TSA is provided below. These types of areas do not contribute to the timber supply of the Lakes TSA. Before assessing timber supply these non-contributing areas are identified and separated from the land base which represents the timber harvesting land base. When deriving this data file, care is taken to make only a single separation for areas with more than one characteristic that would make it unavailable for harvesting (for example, where a park area is also suitable for wildlife habitat).

Identifying areas as not contributing to timber supply does not mean the area is also removed from the Lakes TSA. The B.C. Forest Service still manages the entire area of the TSA (except for designated areas under the jurisdiction of other agencies) as a land unit that contributes a mix of timber and non-timber values. The timber supply is managed within this integrated resource context, and the analysis described herein is consistent with this philosophy.

This section describes the types of areas not contributing to the timber harvesting land base. Use of the term timber harvesting land base in this report does not mean the area is open to unrestricted logging. Rather, it implies that forests in the area contain timber of sufficient economic value — and sites of adequate environmental resilience — to accommodate timber harvesting with due care for other resources.

Operability
Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.

Stocking
The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.

2 Information Preparation for the Timber Supply Analysis

For the Lakes TSA, the following types of areas were excluded from the timber harvesting land base:

- areas not managed by the B.C. Forest Service — this includes private land, parks, Woodlot Licences* and a *Community Forest Pilot Agreement.*
- new protected areas — the location of new protected areas was mapped and overlaid on the inventory file. This permitted the exclusion of the areas from the timber harvesting land base.
- non-productive areas — areas not occupied by productive forest cover (e.g., rock, swamp, alpine areas and water bodies).
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.
- environmentally sensitive areas (ESA)* — areas with sensitive soils that may be damaged by harvesting activities, areas with sensitivity for recreation, areas where forest regeneration would be problematic, and areas of critical caribou habitat were partially excluded based on an area exclusion factor.
- inoperable areas* — areas classified as unavailable for harvest for terrain-related or economic reasons or because they are inaccessible were partially excluded based on an area exclusion factor.
- sites with low timber productivity — areas occupied by forest with low timber-growing potential.
- problem forest types* — stands which are physically operable and exceed low site criteria yet are not currently utilized or have marginal merchantability. In the Lakes TSA, these types include deciduous* stands, non-merchantable balsam stands and stands that do not produce timber of sufficient height.
- existing roads, trails and landings (RTL) — areas occupied by permanent roads and landings.
- riparian areas* — areas unavailable for timber harvesting to protect riparian habitat* and stream ecosystems.
- wildlife tree* patch areas (WTP) — areas reserved within and along the edges of cutblocks* for the maintenance of stand-level biodiversity* (stand structure), primarily for conservation or enhancement of wildlife.

Woodlot licence
An agreement entered into under the Forest Act. *It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.*

Environmentally sensitive areas
Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of avalanches.

Inoperable areas
Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.

Forest type
The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.

Deciduous
Deciduous trees commonly have broad-leaves and usually shed their leaves annually.

Riparian area
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

Riparian habitat
The stream bank and flood plain area adjacent to streams or water bodies.

Wildlife tree
A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

Cutblock
A specific area, with defined boundaries, authorized for harvest.

Stand-level biodiversity
A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.

A more detailed description of these categories, including specific criteria for identification is located in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Table 2 summarizes the areas in each category and shows the total area of the timber harvesting land base.

The column "Productive forest area by classification" provides the total productive forest area managed by the B.C. Forest Service within each category. Because there is a high degree of overlap among land classification categories, the order in which the reductions are made influences the amount of area attributed to each reduction category. For example, while there is a total of 974 hectares of land classified as inoperable, only 508 hectares were removed specifically due to inoperability. The difference arises because one area can be in more than one classification (e.g., inoperable and environmentally sensitive), and the actual area deducted depends on the point at which the reduction occurs in the sequence. Further, partial reductions are sometimes employed to represent situations where parts of areas are excluded from the timber harvesting land base to protect a particular value.

The current timber harvesting land base in the Lakes TSA represents about 52% of the total TSA area and about 79% of the Crown productive forest. The three categories which most reduce the availability of the productive forest for timber supply are: problem forest types (deciduous and other non-merchantable forest types*) (7.7%), riparian areas (6.0%), and environmentally sensitive areas (4.2%). The remaining reduction categories represent 2.9% of the productive forest. The percentages provided depend on the order in which each class is considered. For instance, inoperable areas would constitute a larger proportion of the reduction if they were considered prior to environmentally sensitive areas.

Non-merchantable forest types
Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.

Table 2. Determination of the timber harvesting land base for the Lakes TSA

Classification	Productive forest area by classification (hectares)	Area (hectares)	Per cent (%) of total TSA area	Per cent (%) of Crown forest land
Total TSA area		1 124 552	100.0	
Not managed by the B.C. Forest Service		221 214	19.7	
Non-forest		158 442	14.1	
Total productive forest managed by the Forest Service[a] (Crown forest)		**744 896**	**66.2**	**100.0**
Reductions to Crown forest:				
Non-commercial cover (brush)	2 872	2 872	0.3	0.4
Environmentally sensitive areas (ESAs)	46 846	31 078	2.8	4.2
Inoperable areas	974	508	0.0	0.1
Sites with low productivity	15 337	13 737	1.2	1.8
Deciduous	36 040	32 457	2.9	4.4
Non-merchantable balsam	4 476	2 142	0.2	0.3
Low height – pine	18 951	15 962	1.4	2.1
Low height – other species	20 379	6 390	0.6	0.9
Existing roads, trails and landings		5 354	0.5	0.7
Riparian areas		44 407	3.9	6.0
Total current reductions		**154 907**	**13.8**	**20.8**
Current timber harvesting land base (includes 10 512 hectares not satisfactorily restocked (NSR)* land)		**589 988**	**52.5**	**79.2**
Future reductions				
Conversion to agriculture		2 009	0.2	0.3
Future roads		26 008	2.3	3.5
Long-term timber harvesting land base		**561 972**	**50.0**	**75.4**

(a) The total productive forest area that contributes to landscape-level biodiversity, which includes parks and protected areas is 827 672 hectares.

Note: Areas and percentages may not sum exactly due to rounding.

Not satisfactorily restocked (NSR) areas
An area not covered by a sufficient number of well-spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.

2 Information Preparation for the Timber Supply Analysis

Figure 2 shows the current composition of the timber harvesting land base by tree species group (see Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis," for a description of these groups). Lodgepole pine stands, both pure and mixed with other species, dominate the Lakes TSA, representing about 76% of stands within the timber harvesting land base. Spruce leading stands represent about 20% and balsam and Douglas-fir leading stands represent about 4% of the timber harvesting land base. After harvest, most stands are expected to be regenerated to the same species, except spruce stands which will be converted to pine-leading stands with a spruce component.

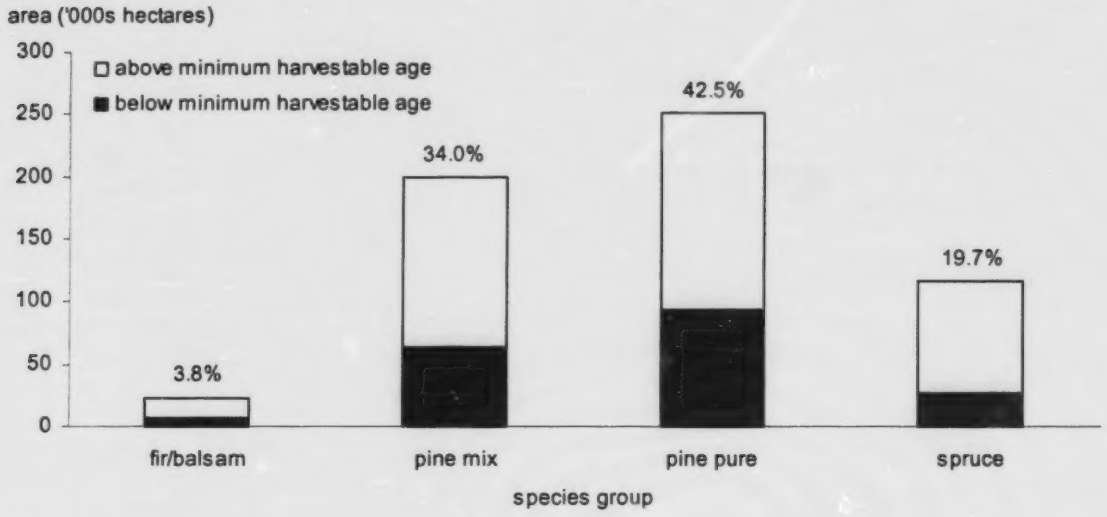

Figure 2. Area by tree species group relative to minimum harvestable age — Lakes TSA timber harvesting land base, 2001.

Figure 2 also shows the proportion of area of each species group that is either younger or older than the minimum harvestable age (see Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" for details on the minimum harvestable age for each species). In total, about 67% of the area in the timber harvesting land base is at or above the minimum harvestable age. There is little variation around this proportion for each of the species groupings: 70% of balsam/fir stands, 62% of pure pine stands, 68% of mixed pine stands, and 76% of spruce stands are currently older than the applicable minimum harvestable age.

2 Information Preparation for the Timber Supply Analysis

Figure 3 shows the distribution of stands by productivity class and species group within the timber harvesting land base. Balsam and fir stands were grouped into a single productivity class, but the other species were classified into good, medium or poor productivity classes based on site index (SI)* (see Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" for details on the site index groupings for each species). For pine and spruce stands, 20% are in the good productivity class, 66% are in the medium productivity class, and 14% are in the poor productivity class. Sites of low productivity are excluded from the timber harvesting land base.

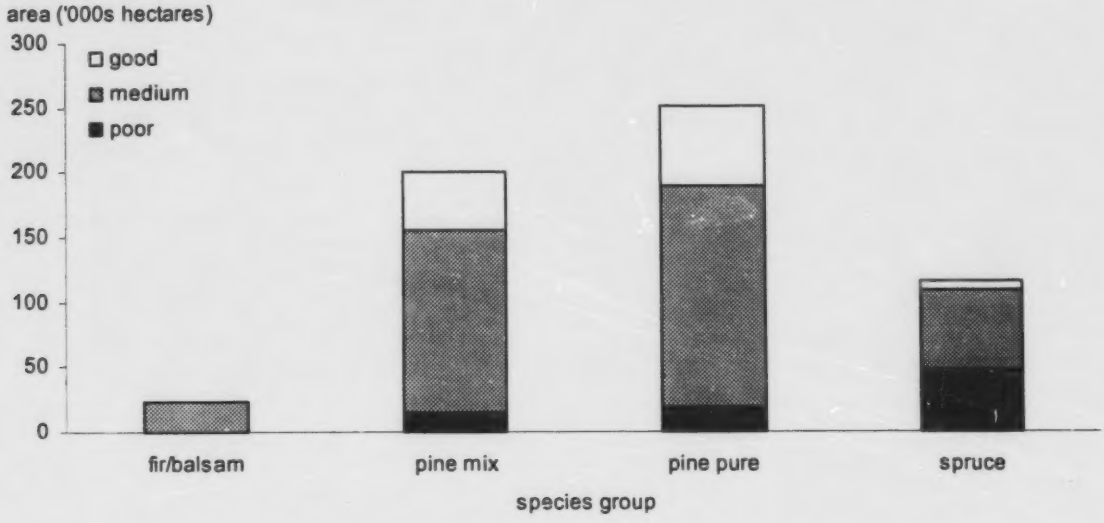

Figure 3. Area by tree species group and timber productivity — Lakes TSA timber harvesting land base, 2001.

Site index
A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

2 Information Preparation for the Timber Supply Analysis

Figure 4 shows the area of the timber harvesting land base by species group and age groups relevant for defining timber yield projections. Stands that are less than 41 years old have managed characteristics and are modelled with managed stand yield curves.

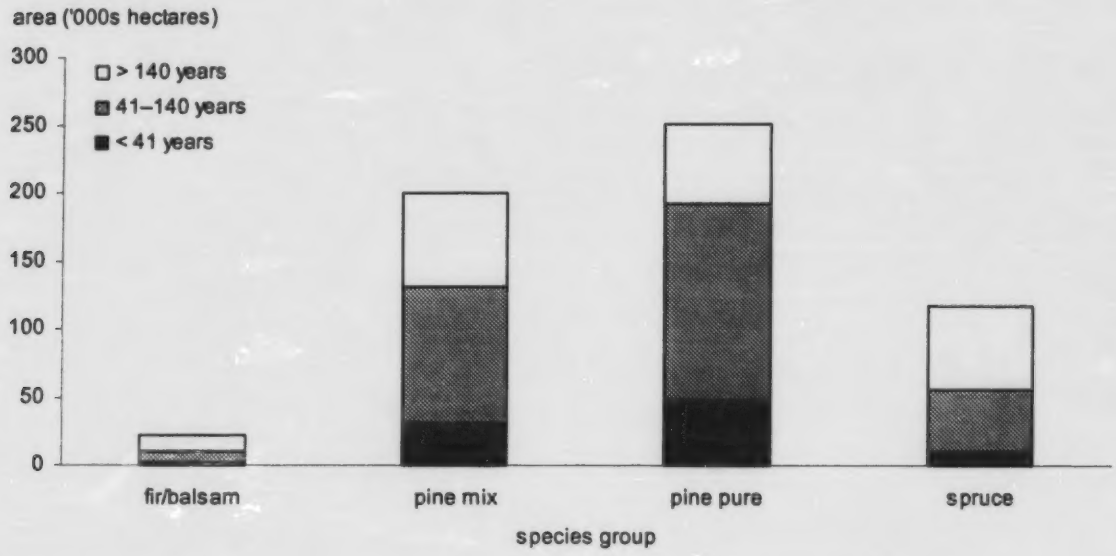

Figure 4. Area by species and age group — Lakes TSA timber harvesting land base, 2001.

2 Information Preparation for the Timber Supply Analysis

Figure 5 shows the current age class distribution of forested stands in the Lakes TSA. Within the timber harvesting land base, 0.7% of the stands are older than 250 years and 34% are older than 140 years. About 14% of stands are 20 years or younger, 25% are between 21 and 100 years old, and 27% are between 101 and 140 years of age.

The preponderance of mature or nearly mature forest in the Lakes TSA means that timber supply in the short and medium terms is defined by the need to ration harvests to provide sufficient time for younger forests and future regenerated stands to reach merchantable condition.

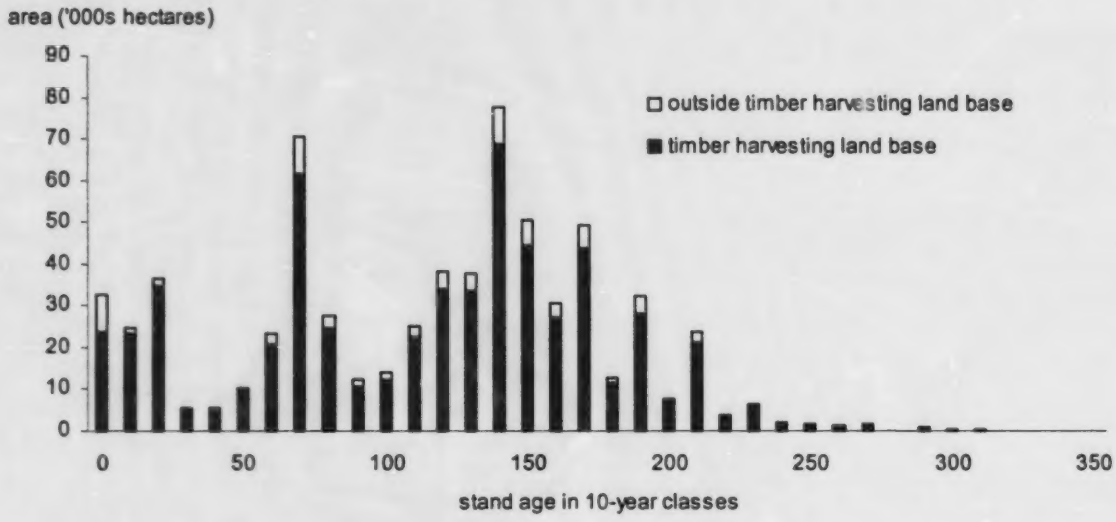

Figure 5. Current age class distribution — Lakes TSA productive forest land base, 2001.

The age class distribution of forested stands excluded from the timber harvesting land base also affects timber supply. In the Lakes TSA, 12% of the total forested land base of 827 672 hectares (which includes some land not managed by the B.C. Forest Service) is covered by these stands. Although they do not contribute directly to the timber supply, they can affect how much harvesting can be conducted and the pattern of the harvesting within the TSA by providing old-forest and biodiversity* attributes. Approximately 33% of these stands outside of the timber harvesting land base are older than 140 years, but less than 1% of these stands are older than 250 years. About 16% of the stands are 20 years or younger, 25% are between 21 and 100 years old, and 26% are between 101 and 140 years of age. The proportion of area in each age group outside the timber harvesting land base is very similar to that of the timber harvesting land base.

Biodiversity (biological diversity)
The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

2.2 Timber growth and yield

Timber growth and yield refers to the prediction of the growth and development of forest stands over time. Forest stands have many characteristics that change over time (for example, number of trees per area, tree diameter, tree height, species composition). Since timber supply analysis concentrates on timber volumes available over time, the most relevant measure for this analysis is volume per unit area (in British Columbia, cubic metres per hectare). An estimate of timber volume in a stand assumes a specific utilization level, or set of dimensions, that establish the minimum tree and log sizes that are removed from a site. Utilization levels used in estimating timber volumes specify minimum diameters both near the base and the top of a tree.

Two growth and yield models were used to estimate timber volumes for the Lakes TSA analysis. The variable density yield prediction (VDYP)* model developed by the B.C. Forest Service, Resources Inventory Branch, was used for estimating timber volumes for all existing natural stands. The table interpolation program for stand yields (TIPSY)* developed by the B.C. Forest Service, Research Branch was used to estimate timber volumes both existing and future managed stands. All coniferous* stands less than 41 years old and coniferous stands that will be harvested in the future were assumed to grow according to managed stand volume estimates* from TIPSY. Managed stand yield tables (MSYT) for lodgepole pine stands include a site productivity adjustment (see Section 2.4.2, "Timber growth and yield changes," for details).

Uncertainty in volume estimation and prediction may result from uncertainty in the inventories that form the inputs for growth and yield models, from variability around the average estimates provided by growth and yield models, from limited experience with second-growth in British Columbia, and from the long time frame over which trees grow. Sensitivity analyses described in Section 5, "Timber Supply Sensitivity Analyses," address the possibility that actual timber volumes may be different from estimates used in this analysis.

Based on timber volume estimates, the current timber inventory or growing stock* on the timber harvesting land base is approximately 131 million cubic metres. Most of this growing stock (about 123 million cubic metres, or 94% of the total) is currently merchantable; that is, older than minimum harvestable age.

2.3 Management practices

Timber supply depends on how the forest is managed for both timber and non-timber values. Therefore, levels of management activity must be defined for the timber supply analysis process. The *Forest Practices Code* and *Lakes Land and Resource Management Plan* guide forest management practices in the Lakes TSA. The focus of the Timber Supply Review is to assess timber supply based on current management practices as implemented in plans for the area. Staff in the Lakes Forest District provided descriptions for the following management practices.

Variable Density Yield Prediction model
An empirical yield prediction system supported by the B.C. Forest Service, designed to predict average yields and provide forest inventory updates over large areas (i.e., Timber Supply Areas). It is intended for use in unmanaged natural stands of pure or mixed composition.

Table Interpolation Program for Stand Yields
A B.C. Forest Service computer program used to generate yield projections for managed stands using a model that simulates the growth of individual trees based on internal growth processes, crown competition, environmental factors and silvicultural practices.

Coniferous
Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.

Volume estimates (yield projections)
Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.

Growing stock
The volume estimate for all standing timber at a particular time

- Silviculture practices — reforestation activities required to establish free-growing* stands of acceptable tree species. Most areas in the Lakes TSA are harvested using a clearcut harvesting* system and restocked by planting.
- Forest health and unsalvaged losses* — timber losses to fire and pest (insect) damage are expected to average 31 976 cubic metres per year over the 250 year analysis horizon. To deal with the high risk of losses due to mountain pine beetle, the highest priority for harvesting is placed on pine stands in the Chelaslie landscape unit* for the first two decades.
- Utilization levels — minimum sizes of trees, and logs to be removed during harvesting
- Cutblock adjacency* and green-up* — in the Lakes TSA, approval of harvesting activities is contingent on previously harvested stands reaching a desired condition, or green-up (three metres in height) before adjacent stands may be harvested. The purpose of the cutblock adjacency guidelines is to prevent timber harvesting from becoming overly concentrated in an area at any time. To approximate the effect of cutblock adjacency, a maximum of 33% of the integrated resource management (IRM)* portion of the timber harvesting land base was allowed to be below green-up condition at any time within each landscape unit.
- Maintenance of scenic values — maintaining important scenic values requires that visible evidence of harvesting must be kept within limits in some areas of the Lakes TSA. The maximum proportion of each scenic area* that may be less than the visually effective green-up (VEG) height varies depending on the forest characteristics and the visual quality class (VQC) for each area, but generally ranges between 2% and 13%. The VEG height was four metres for the partial retention visual quality class and five metres for the retention visual quality class within significant visual areas, and three metres for partial retention and four metres for the retention visual quality class within other visual management areas.

Free-growing
An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Clearcut harvesting
A harvesting method in which all trees are removed from an area of land in a single harvest. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding. Note that retention of some live trees and snags for purposes of biodiversity now occurs on most clearcuts.
Unsalvaged losses
The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Landscape unit
A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

Cutblock adjacency
The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Integrated resource management (IRM)
The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.
Scenic area
Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.

- Minimum harvestable ages (MHA) — the time it takes for stands to grow to a merchantable condition. Minimum harvestable ages were defined as the age at which a stand reaches a minimum volume of 140 cubic metres per hectare and a minimum height of 17.5 metres for pine stands or 19.5 metres for other stands. Actual harvest ages may be greater but not less than the minimum, and will depend on ages of other available stands, forest cover objectives* and overall timber harvest targets.
- Landscape-level biodiversity* — to maintain biological diversity, each draft landscape unit and biogeoclimatic ecosystem classification (BEC) variant* is required to have at all times a minimum amount of forested area in stands with old-forest characteristics. The amount of old forest required depends on the natural disturbance type (NDT)* associated with each BEC variant.
- Maintenance of habitat — various requirements related to maximum allowable disturbance (green-up) and minimum retained old forest area were used to model maintenance of suitable habitats for caribou, moose, deer and grizzly bear. The requirements varied by the type of wildlife and are described in detail in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis."
- Backcountry lakes — maximum allowable disturbance and green-up height requirements were used to maintain recreation and scenic values around backcountry lakes.
- Conversion of forest land to agriculture — some Crown forested land is forecast to be harvested and converted to agricultural use. This was estimated to occur at the rate of 50 hectares per year for four decades.

Forest cover objectives
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see ***Cutblock adjacency*** *and* ***Green-up****).*
Landscape-level biodiversity
The Landscape Unit Planning Guide *provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.*

Biogeoclimatic (BEC) variant
A subdivision of a biogeoclimatic sub-zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Natural disturbance type (NDT)
An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas subject to less frequent stand-initiating disturbance usually have more older forests

- *Lakes Land and Resource Management Plan (LRMP)* — the Lakes *LRMP* was approved by government in April 2000 and is accounted for in the base case. Parts of the *LRMP* were established as a higher level plan* under the *Forest Practices Code* in September 2000. All of the protected areas that affect the timber harvesting land base were designated in February 2001 under the *Park Act* or the *Environment and Land Use Act*, except for the Sutherland protected area and several boating sites on Babine Lake. These are scheduled for designation by the summer of 2001. The *LRMP* contains direction for significant visual and visual areas, recreation zone, backcountry lakes, wildlife habitat and landscape-level biodiversity. For landscape-level biodiversity, it requires that all of the seral stage* requirements recommended by the *Biodiversity Guidebook* be applied (i.e., early, mature and old seral* requirements), without phasing in the old seral requirements in landscape units with a low biodiversity emphasis option (BEO).

More detailed descriptions of these management practices and the assumptions used to assess their impacts on timber supply are included in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis."

Higher level plans
Higher level plans establish the broader, strategic context for operational plans, providing objectives that determine the mix of forest resources to be managed in a given area.

Seral stages
Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.

Old seral
Old seral refers to forests with appropriate old forest characteristics. Ages vary depending on forest type and biogeoclimatic variant.

2 Information Preparation for the Timber Supply Analysis

Figure 6 shows the distribution of the timber harvesting land base by management emphasis. There is some overlap between the visual quality objectives (VQO)* within the visual management zones and the habitat zones, and between the agriculture conversion zone and the ungulate winter habitat zone. However, there is no overlap among the habitat zones or between the integrated resource management (IRM) zone and any other zone. The IRM zone accounts for less than one-half (44%) of the timber harvesting land base.

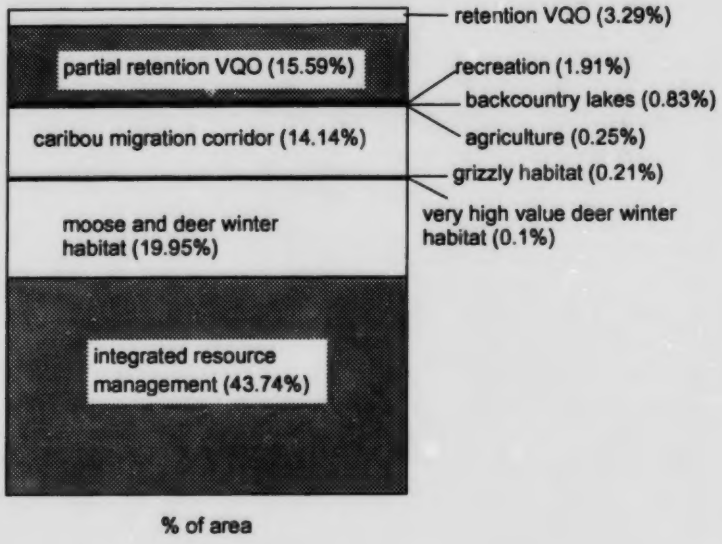

Figure 6. Area by management emphasis — Lakes TSA timber harvesting land base, 2001.

Visual quality objective (VQO)
Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.

2 Information Preparation for the Timber Supply Analysis

Table 3 shows the distribution (area and proportion) of the Crown productive forest and timber harvesting land base by biogeoclimatic ecosystem classification (BEC) variant. There are 188 hectares of the timber harvesting land base labelled as the ATp variant, but this is a negligible proportion of the timber harvesting land base. This alpine tundra variant does not usually contain merchantable timber, but occurs because the scale of BEC mapping is coarser than the scale of the forest cover inventory, so it is possible that the ATp area overlaps the area of merchantable timber in the forest cover inventory. The SBSdk and SBSmc2 variants account for 91% of the timber harvesting land base. Only 8% of the timber harvesting land base occurs in ESSF variants, which represent high elevation sites.

The last column in Table 3 shows the proportion of the total area of each BEC variant that is in the timber harvesting land base. Most variants have more than 50% of their area in the timber harvesting land base. The two dominant variants (SBSdk and SBSmc2) each have more than 70% of their area in the timber harvesting land base. This indicates that the timber harvesting land base could be important in contributing to biodiversity requirements (such as old forest retention) because such requirements are applied at the landscape unit level.

Table 3. Area of productive forest by biogeoclimatic ecosystem variant and timber harvesting land

BEC variant	Productive forest (hectares)	Per cent (%) of productive forest	Timber harvesting land base (hectares)	Per cent (%) of timber harvesting land base	Per cent (%) of BEC variant in timber harvesting land base
ATp	1 235	0.2	188	0	14.5
ESSFmc	58 280	7.8	37 721	6.4	63.8
ESSFmv1	6 380	0.9	4 774	0.8	66.5
ESSFmv3	10 365	1.4	5 352	0.9	51.6
SBSdk	366 617	49.2	289 559	49.1	73.3
SBSdw3	312	0	241	0	77.1
SBSmc2	297 128	39.9	248 238	42.1	81.9
SBSwk3	4 580	0.6	3 915	0.7	85.5
Total	744 897	100	589 988	100	

2.4 Changes since the 1995 Lakes TSA timber supply analysis

A number of changes have occurred to the land base, timber growth and yield information, and forest management assumptions since the last timber supply analysis in 1995.

2.4.1 Land base changes

Changes to the land base assumptions were:

- Protected areas — the Lakes *LRMP* establishes new protected areas. Some were legally established under the *Park Act* or the *Environment and Land Use Act* in February 2001, and the rest are scheduled for designation by the summer of 2001. These new protected areas cover 95 248 hectares, of which 21 074 hectares would have been within the timber harvesting land base.
- Woodlot Licences — woodlot licences do not form part of the TSA timber harvesting land base and have their AACs determined independently of the timber supply review process. A number of woodlot licences have been created or expanded since the 1995 analysis, so they have been removed from the timber harvesting land base. When defining the current AAC attributable to the TSA, the woodlot AACs (38 000 cubic metres per year) were removed from the total of 1.5 million cubic metres to arrive at 1.462 million cubic metres per year.
- Community Forest — in July 2000, a *Community Forest Pilot Agreement* was awarded to Burns Lake Community Forest Ltd. The *Pilot Agreement* is a fixed area tenure covering 22 708 hectares adjacent to Burns Lake. The AAC for the *Pilot Agreement* will be set separately from the AAC for the Lakes TSA, so the area of the *Pilot Agreement* has been removed from the timber harvesting land base.
- Environmentally sensitive areas (ESA) — after the 1995 timber supply analysis, the reduction percentages for sensitive soil areas were refined to account for the different sensitivity of S1 and S2 areas and for sensitivity differences among public sustained yield units. Removals for high value localized recreation areas were reduced because some harvesting may occur there.
- Operability — in the 1995 analysis, harvesting in the Sutherland Valley was deferred for 10 years, after which the IRM adjacency and green-up requirements were applied. In this analysis, 70% of the parts of the valley that are within and adjacent to the floodplain were removed for high soil hazard and erosion hazard, and no deferral was used. This affects only those parts of the side drainages* that lie outside of the new Sutherland protected area established under the *LRMP*.

Drainage
The surface and sub-surface water derived within a clearly defined catchment area, usually bounded by ridges or other similar topographic features, encompassing part, most, or all of a watershed. The term is sometimes used to describe an operating area or location.

- Problem forest types:
  - In the 1995 analysis, the minimum height criteria for all species was 19.5 metres. Following a review of harvest practices, the criterion was reduced to 17.5 metres for pine.
  - The 1995 analysis only removed mature stands using the low height criteria. This analysis converted the minimum height criteria to minimum site index criteria, which were used to identify which existing stands will not likely ever meet the minimum height criteria.
  - The 1995 analysis removed pine stands with stocking class 4; this analysis did not.
- Roads, trails and landings — following a review of current practice, the deduction for roads, trails and landings was reduced from 5.4% to 5.24%.
- Riparian areas — the 1995 analysis identified a riparian zone and applied forest cover requirements* for green-up and old-forest retention. This analysis calculated the area in riparian reserve zones (RRZ) and part of the riparian management zones (RMZ) and removed it from the timber harvesting land base, as indicated in the *Forest Practices Code.*
- Conversion of forest land to agriculture — the conversion of Crown forested land to agriculture (2009 hectares) is new in this analysis.
- Not satisfactorily restocked (NSR) land — the 1995 analysis removed NSR land from the calculation of the current timber harvesting land base and added a portion of it back in for the long-term timber harvesting land base. This analysis includes NSR in the current timber harvesting land base. This change only affects the area reported in Table 2; it does not affect how NSR land is handled in the timber supply model.

The timber harvesting land base was reduced for protected areas, woodlot licences, community forest, operability, riparian areas, and stand-level biodiversity. Conversion of forest land to agriculture reduces the long-term timber harvesting land base. The new reductions in roads, trails and landings increase the timber harvesting land base. The change for NSR did not affect the timber harvesting land base because NSR was handled within the timber supply model instead of being reported as a removal when calculating the current timber harvesting land base.

Two sets of changes had mixed impacts on the timber harvesting land base. Reducing the height limit for the pine problem forest type acted to increase the timber harvesting land base, but converting the height criteria for all species to site index criteria and applying them to young stands acted to decrease it. Reducing the percentage deductions for ESAs acted to increase the timber harvesting land base, but removing the high value caribou habitat acted to decrease it.

Forest cover requirements
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see ***Cutblock adjacency*** *and* ***Green-up****).*

2 Information Preparation for the Timber Supply Analysis

Table 4 compares the timber harvesting land bases for the 1995 and current analyses. To facilitate the comparison, the current timber harvesting land base for the 1995 analysis includes the NSR land that was returned. The net impact was a reduction in the current timber harvesting land base of about 11%. New protected areas account for 21 074 hectares and new removals from the productive forest for riparian areas account for 44 407 hectares. These removals are slightly less than the change in current timber harvesting land base. This suggests that the timber harvesting land base would still be smaller for the 2001 analysis due to changed criteria for the other removals.

Table 4. Comparison of the timber harvesting land base for the Lakes TSA with the 1995 analysis

Timber harvesting land base	1995 analysis	2001 analysis	Change 1995 to 2001	
			Hectares	Per cent (%)
Current	658 025	589 988	– 68 337	– 11.3
Long term	634 487	561 972	– 72 515	– 11.4

2.4.2 Timber growth and yield changes

Changes to timber growth and yield assumptions were:

- Site productivity — the results of a paired-plot study undertaken in the Lakes TSA (Goudie, 1996) has produced scientifically derived, statistically reliable estimates of potential site productivity for pine in the TSA. These results were used to adjust the site index for regenerated pine stands within the SBSdk and SBSmc2 BEC variants. (However, the adjustments were not applied within the following management areas: very high value caribou migration corridor, backcountry lakes, the strong link component of the biological ecosystem network, and retention VQOs*. These areas have restrictive forest cover requirements and regenerated stands are not expected to achieve the paired plot site index.)

  This change in estimating site productivity substantially increased the site index of pine stands. Site index for pine stands in the SBSdk BEC variant increased uniformly to about 20 metres at base age 50, regardless of their initial site index. Site index of pine stands in the SBSmc2 variant increased to 18 – 22 metres at base age 50, depending on their initial site index. This large increase in pine site index acted to increase managed stand timber yield estimates and to decrease green-up periods and minimum harvestable ages.

- Operational adjustment factors (OAF) — operational adjustment factors are used to adjust timber yield estimates to account for operational factors. OAF1 is a constant percentage reduction to account for small unproductive areas within stands, uneven stem distribution and endemic losses that do not increase with age. OAF2 accounts for losses that increase with stand age, for example decay due to disease. Provincial average OAF values are usually applied to the managed stand yield curves as recommended by the Ministry of Forests, Research Branch, as no local values are available. However, this analysis used an OAF1 value of 20% instead of 15% to account for additional impacts due to stem rusts in stands with a pine component of at least 80%.

Retention VQO
*Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity (see **Visual quality objective**).*

2.4.3 Forest management changes

Changes to the forest management assumptions were:

- Minimum harvestable ages — in the 1995 analysis, minimum harvestable ages were set at culmination age*. In this analysis, minimum harvestable ages were set at the age when a stand reaches a minimum volume of 140 cubic metres per hectare and a minimum height of 17.5 metres for pine or 19.5 metres for other species. This reduced minimum harvestable ages by up to 30 years compared with the 1995 analysis.
- Scenic areas — after the 1995 analysis, a review by the Lakes Forest District staff resulted in the reclassification of some scenic areas to less sensitive visual quality classes. The *LRMP* subsequently provided additional direction on visual areas. Areas with VQOs covered 24% of the timber harvesting land base in the 1995 analysis, compared with 19% in this analysis. Furthermore, green-up heights were reduced from 6.5 metres for all VQOs to three to five metres depending on VQOs and visual management significance.
- Habitat requirements — this analysis has refined the caribou migration corridor. It contains new forest cover requirements for the moderate value caribou migration corridor that did not appear in the 1995 analysis but were considered to be current practice and were accounted for in the last AAC determination. The *LRMP* has also added additional forest cover requirements for the caribou migration corridor.

  Ungulate winter habitat requirements were refined in this analysis by differentiating between moose and deer habitat. Deer habitat has slightly more restrictive forest cover requirements, but these only apply to 596 hectares of the timber harvesting land base.

  Grizzly bear habitat requirements were accounted for implicitly in the 1995 analysis by the requirements for riparian complexes and a deferral of harvesting in the Sutherland valley. This analysis accounted explicitly for grizzly bear habitat requirements with separate forest cover requirements, but they only apply to 1215 hectares (0.2%) of the timber harvesting land base.
- Recreation areas — these areas are new in this analysis. The *LRMP* imposes restrictive green-up requirements, but they only apply to 11 253 hectares of the timber harvesting land base (1.9%).
- Backcountry lakes — These areas were accounted for implicitly in the 1995 analysis because of the overlap with retention and partial retention VQOs*. This analysis applied separate forest cover requirements for backcountry lakes. They have very restrictive green-up requirements, but they only apply to 4865 hectares of the timber harvesting land base (0.8%).
- Landscape-level biodiversity —landscape-level biodiversity requirements from the *Forest Practices Code* and the *LRMP* are new in this analysis. The *LRMP* requirements apply to all seral stages.
- Stand-level biodiversity — this analysis reduced timber volumes to account for wildlife tree patch retention objectives of the *Forest Practices Code*.
- Management requirements for scenic areas, habitat, recreation areas and backcountry lakes were applied by landscape unit in this analysis to prevent concentration of harvesting. This is generally more restrictive than applying them to a management zone representing all areas subject to a set of management objectives over the entire TSA, as was done in the 1995 analysis.

Culmination age
The age at which a timber stand reaches its highest average growth rate, or mean annual increment (MAI). MAI is calculated as stand volume divided by stand age. Culmination age is the optimal biological rotation age to maximize long-term volume production from a growing site.

Partial retention VQO
*Alterations may be visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see **Visual quality objective**).*

Changes in forest management assumptions do not affect the timber harvesting land base. Instead, they act by either adding or removing management constraints in the timber supply model. The changes to minimum harvestable ages and scenic areas acted to remove management constraints. The significantly lower minimum harvestable ages produced greater flexibility to harvest some younger, but still merchantable, stands in periods when older, higher volume stands are projected to be in short supply. The shortage of stands currently between the ages of 21 and 50 was identified as the prime cause of the medium-term timber supply shortage in the 1995 analysis. The changes for scenic areas reduced the area subject to VQOs as well as relaxing the management constraints on the remaining areas with VQOs.

The addition of requirements for landscape-level biodiversity acts to reduce timber supply by placing restrictions on the distribution of age classes, which removes flexibility to harvest timber. Accounting for wildlife tree patches by reducing timber volumes reduces the total amount of timber available for harvest.

One of the impacts of changes to management assumptions is that a greater proportion of the timber harvesting land base is subject to forest cover requirements other than for adjacency. Compared with the 1995 analysis, the IRM zone has decreased from 58% to 46% of the timber harvesting land base. This change is mainly due to increased management requirements in the caribou migration corridor, which transferred area out of the IRM zone. These requirements were not included in the 1995 analysis, but they were subsequently taken into account when the current AAC was established in 1996.

2.4.4 Summary of changes

In summary, the timber harvesting land base has decreased in size by 11%, and the timber growth and yield assumptions and the definition of current practices have changed considerably since the 1995 analysis. Given the extent of these changes, direct comparisons between this and the previous analysis cannot be made. Each analysis needs to be evaluated in the context of the management regime and related data inputs and assumptions applied at the time (see Appendix A of the respective reports). As noted in the introductory section, there is uncertainty surrounding information used in analyses and forest management objectives change over time, which is why the *Forest Act* requires the chief forester to periodically review the timber supply and AAC for each TSA.

Any changes to the land base or management assumptions that may occur or become effective after the completion of this timber supply analysis will be presented to the chief forester for consideration during the AAC determination, if possible.

3 Timber Supply Analysis Methods

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Lakes TSA, in light of current forest management practices. A timber supply computer simulation model developed by the B.C. Forest Service (FSSIM version 3.0) was used to aid in the assessment. A timber supply model, as distinct from a growth and yield model, assists the timber supply analyst in determining how a whole forest (collection of stands) could be managed to obtain a harvest forecast (supply of timber over time). The simulation model uses information about the timber harvesting land base, timber volumes, and the management regime to represent how trees grow and are harvested over a long period of time. Generally, only the results for the first 250 years are shown graphically in this report because the harvest level remains constant after that time.

Similar to other models, the B.C. Forest Service model assumes that trees grow according to provided yield projections and are harvested according to either a volume target or a specified objective set by the analyst, such as harvest volume maximization. The Forest Service model also allows the use of forest cover guidelines that specify the desired age composition of the forest. These guidelines can be used to examine the effects of cutblock adjacency and green-up prescriptions. For example, guidelines might specify that no more than some maximum percentage of the forest can be younger than a specified green-up age, or that some minimum percentage of the forest must be in older age classes to provide wildlife habitat. The B.C. Forest Service simulation model facilitates examination of the effects of such guidelines on timber supply.

This type of analysis is used to determine the timber supply implications of a particular timber harvesting regime. The results of the analysis are especially important in determining allowable cuts that will not restrict options of future resource managers, and that will assist local B.C. Forest Service staff to administer their programs according to relevant guidelines and principles. However, the results of the analysis are not meant to be taken as recommendations of any particular AAC.

The main results of the analysis are forecasts of potential timber harvests and timber inventory changes (ages and volumes) over time. Although this information gives field staff only very limited guidance in the design of operational activities such as harvesting block location and silviculture planning, it does help ensure that the timber harvest level supports rather than hinders sustainable forest management in the field.

4 Results

This section presents results of the timber supply analysis for the Lakes TSA. The base case harvest forecast* uses the most recent assessments of current forest management, the land available for timber harvesting, and timber yields as described in Section 2, "Information Preparation for the Timber Supply Analysis." Because forest management is inherently a long-term venture, uncertainty surrounds much of the information important in determining timber supply. This uncertainty will be discussed in Section 5, "Timber Supply Sensitivity Analyses." Section 6, "Critical Issue Analysis — Mountain Pine Beetle Outbreak," presents and discusses additional analysis results for an issue of current importance in the TSA. The base case provides only a part of the timber supply picture for the Lakes TSA, and should not be viewed in isolation of the sensitivity analysis*.

4.1 Base case harvest forecast

The base case harvest forecast accounts for all of the changes since 1995 including the Lakes *LRMP* and the *Community Forest Pilot Agreement*. The base case harvest forecast was developed by first determining the maximum sustainable long-term harvest level*. This harvest level should produce a growing stock that is stable in the long term, so that harvesting can continue at that level in perpetuity. Falling long-term growing stock indicates that timber is being harvested above the productive capability of the land. Once the long-term harvest level has been determined, the next step is to maintain the current harvest level as long as possible, with reductions of no more than 10% per decade to provide an orderly transition to the long-term harvest level.

Base case harvest forecast
The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information

Sensitivity analysis
A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.
Long-term harvest level
A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.

4 Results

Figure 7 shows the base case harvest forecast for the Lakes TSA. The current harvest level of 1 462 000 cubic metres per year is maintained for 11 decades. In decade 12, the harvest level increases by approximately 16% to the long-term harvest level of 1 695 000 cubic metres per year, when most of the harvest comes from regenerated stands. Unsalvaged losses due to natural forces such as insects and fire are estimated to be 31 976 cubic metres per year for the entire 250-year horizon and have been subtracted from all harvest forecasts shown in this report.

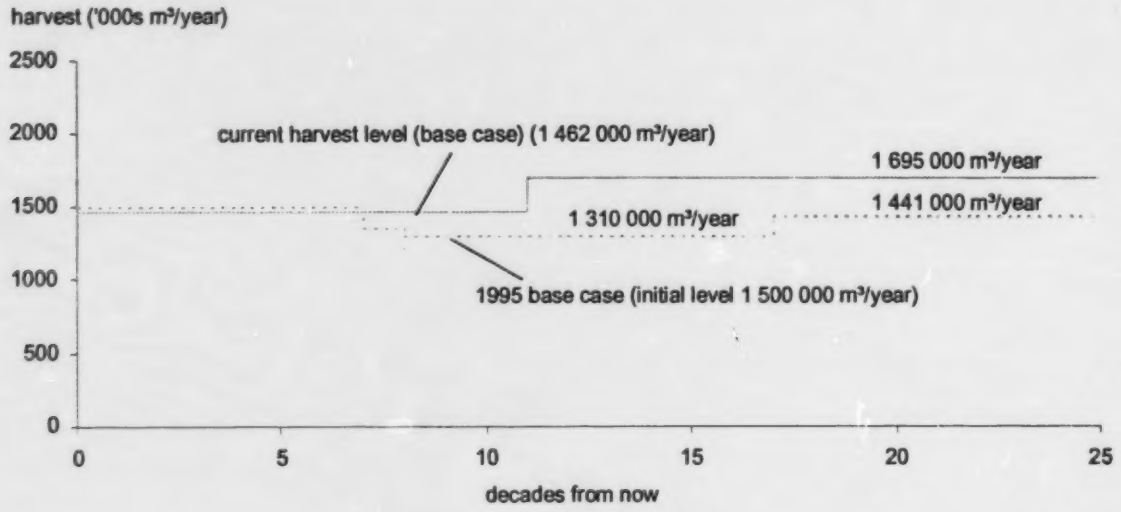

Figure 7. Current and 1995 base case harvest forecasts — Lakes TSA, 2001.

This base case for this analysis shows a non-declining harvest level (i.e., they rise but do not fall), whereas the 1995 base case maintained its initial harvest level for 70 years before falling to a mid-term level and then rising to the long-term level at 180 years.

4 Results

Section 2.4, "Changes since the 1995 Lakes TSA analysis," provides an overview of the major changes to the land base, timber growth and yield, and management assumptions since the 1995 analysis. The summary concludes that any comparison between this and the 1995 analysis should be made with recognition of the extent and nature of those changes. Each analysis should be evaluated in the context of the management regime and related data inputs and assumptions that applied at the time. Finally, one of the major reasons the chief forester is required under the *Forest Act* to periodically review the timber supply and AAC is to account for changes in management, as well as new information that may resolve some uncertainties.

Four main factors caused the differences between this base case and the 1995 base case. First, the *Lakes LRMP* established new management practices and new protected areas. Second, the *Community Forest Pilot Agreement* reduced the size of the timber harvesting land base.

The third main factor is that minimum harvestable ages were significantly lower in this analysis. This increased flexibility to harvest some younger, but still merchantable, stands in periods when older, higher volume stands are in short supply. This flexibility reduced the need for harvest levels to fall in the medium term. The shortage of stands currently between the ages of 21 and 50 was identified as the prime cause of the medium-term timber supply shortage in the 1995 analysis.

The fourth main factor is the change in timber yield curves resulting from the site index adjustments for regenerated pine stands. It eliminates any remaining medium-term timber supply shortfall and increases the long-term sustainable harvest level.

All other changes in land base and management assumptions appear to have had a minor impact on timber supply compared with the four main factors. However, the recent outbreak of mountain pine beetle in the TSA has significant implications to timber supply. This is discussed in Section 6, "Critical Issues Analysis – Mountain Pine Beetle Outbreak."

4.2 Base case timber supply dynamics

Figure 8 shows the contribution of existing and managed stands to the base case harvest forecast. The transition to managed stands begins after seven decades and is almost complete after 17 decades. Existing stands continue to contribute small amounts after decade 17, mostly from areas with restrictive forest cover requirements, such as VQOs, backcountry lakes and recreation areas.

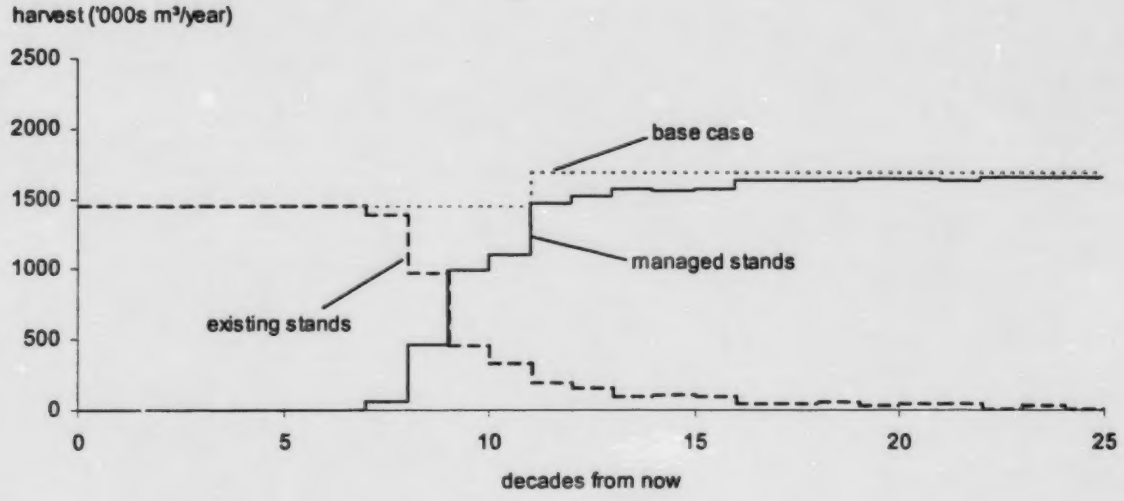

Figure 8. Harvest contributions from managed stands — Lakes TSA base case harvest forecast, 2001.

4 Results

Figure 9 shows the contribution to the base case harvest forecast from areas under different management emphasis. The contribution from each management emphasis fluctuates somewhat over time. The IRM area contributes 39 to 57% of the harvest in each decade. The caribou migration corridor contributes 9 to 33% and other habitat areas (grizzly, moose and deer) contribute 15 to 36%. Scenic areas contribute 6 to 15%. Scenic areas overlap with other management emphases (except for IRM), so summing the harvests by management emphasis exceeds the total base case harvest forecast. Special management zones (backcountry lakes) contribute less than 1% because of their small area and restrictive management requirements.

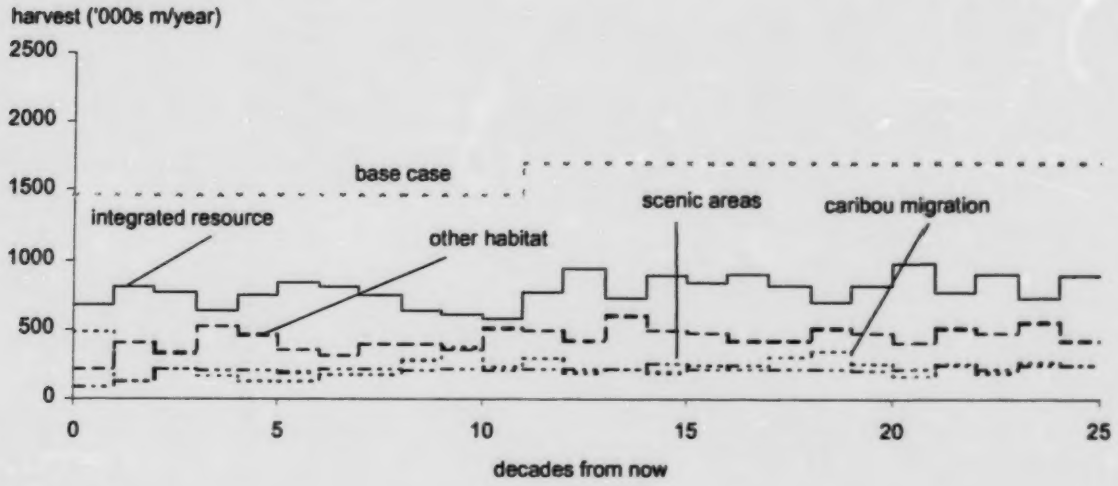

Figure 9. Harvest contribution by management emphasis — Lakes TSA base case harvest forecast, 2001.

4 Results

Figure 10 shows growing stock levels for the timber harvesting land base. The total growing stock declines slowly, but stabilizes after decade 40 (not shown). The maximum non-declining harvest alternative shown in Figure 14 in Section 5.1, "Alternative harvest flows over time" has stable growing stock after decade 12. The merchantable growing stock levels are similar to the total growing stock levels because of the low minimum harvest ages used in the timber supply analysis. The growing stock for managed stands grows quickly until decade 10, after which it grows more slowly as a result of increased harvesting in managed stands.

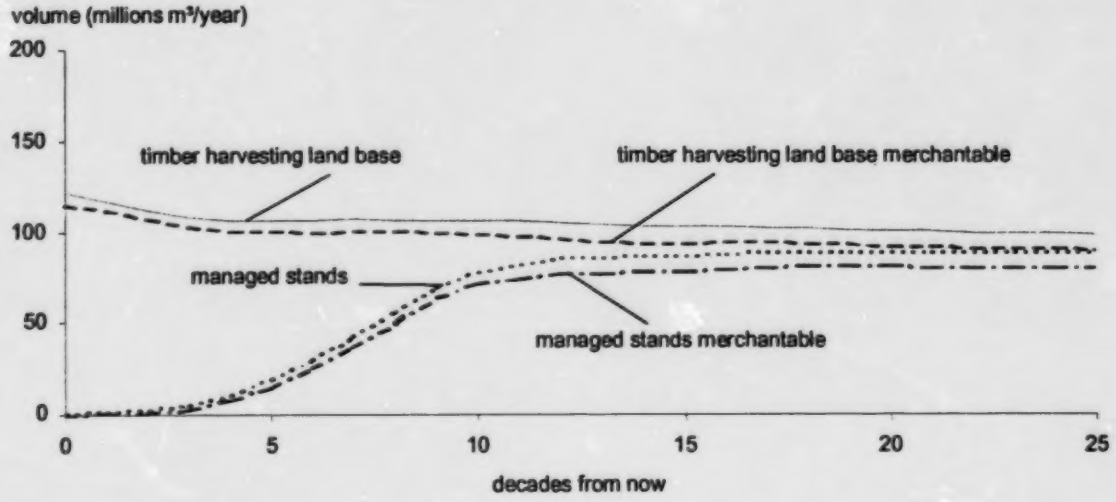

Figure 10. Timber growing stock forecasts — Lakes TSA base case harvest forecast, 2001.

4.3 Area, average volume and average age harvested

Figure 11 shows the average annual area harvested and the average volume per hectare harvested in each decade. The average annual yield fluctuates slightly over the planning horizon, ranging from approximately 310 cubic metres per hectare to 345 cubic metres per hectare. The average annual area harvested fluctuates slightly during the first 11 decades, ranging from approximately 4385 hectares to 4850 hectares. After decade 11, the harvest level increases to the long-term harvest level, and the average annual area harvested also increases, ranging from approximately 5005 hectares to 5495 hectares.

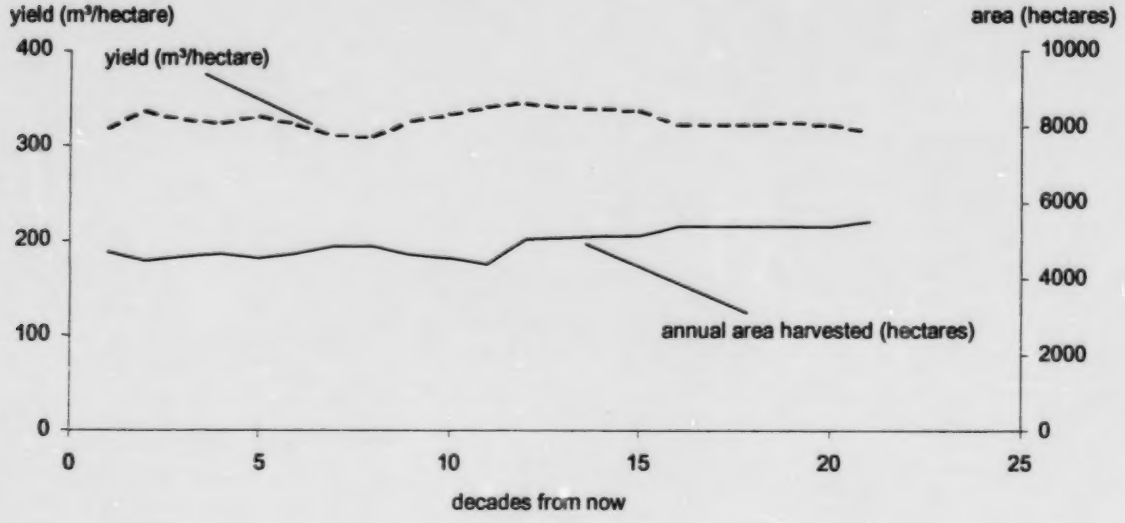

Figure 11. Average volume yield and average annual area harvested — Lakes TSA base case harvest forecast, 2001.

4 Results

Figure 12 shows the average age (weighted by area) of the stands harvested in each decade by management emphasis. The average harvest age generally declines as a result of the transition from harvesting old existing stands to younger managed stands. The only exception is in the backcountry lakes where the restrictive management requirements limit harvesting to such an extent that timber is projected to continue to grow older. The average harvest age in the long term is around 125 years for the caribou migration corridor, 105 years for other habitat, 310 years for special zones (backcountry lakes and recreation areas), 150 years for scenic areas, and 100 years for the IRM area.

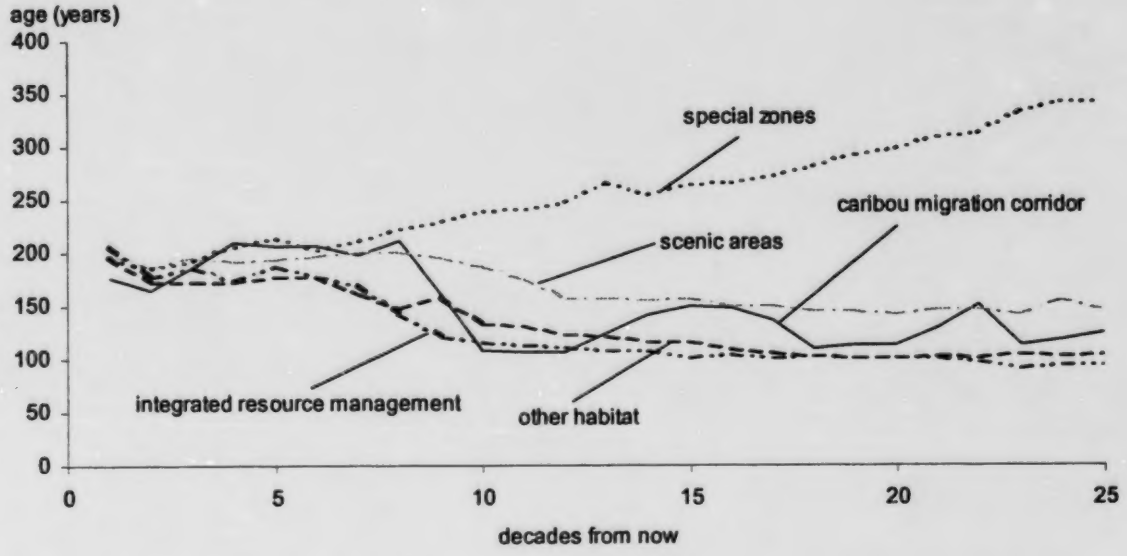

Figure 12. Average area-weighted harvest age — Lakes TSA base case harvest forecast, 2001.

4.4 Age class distribution over time

The charts in Figure 13 show how the distribution by 10-year age classes of the productive forest is projected to change under the base case harvest forecast. The current age class distribution has two significant gaps in the 30 to 50 year age classes and in the 90 to 100 year age classes. These gaps do not cause any disruptions in timber supply as was forecast in the 1995 analysis, because of the effects of the reduced minimum harvest ages and the increased site productivity in managed pine stands.

By year 150, the age class distribution is forecast to be relatively even in stands under 100 years of age. By year 250, very little area in the timber harvesting land base is projected to remain above age 150. The area that remains in these old age classes reflects habitat and landscape-level biodiversity requirements, and the higher average harvest ages outside of the IRM management emphasis, particularly in scenic areas. The charts also reflect the assumption in the timber supply model that the relatively small area of forest outside of the timber harvesting land base simply ages with time. The implications of this assumption were tested in a sensitivity analysis (see Section 5.5).

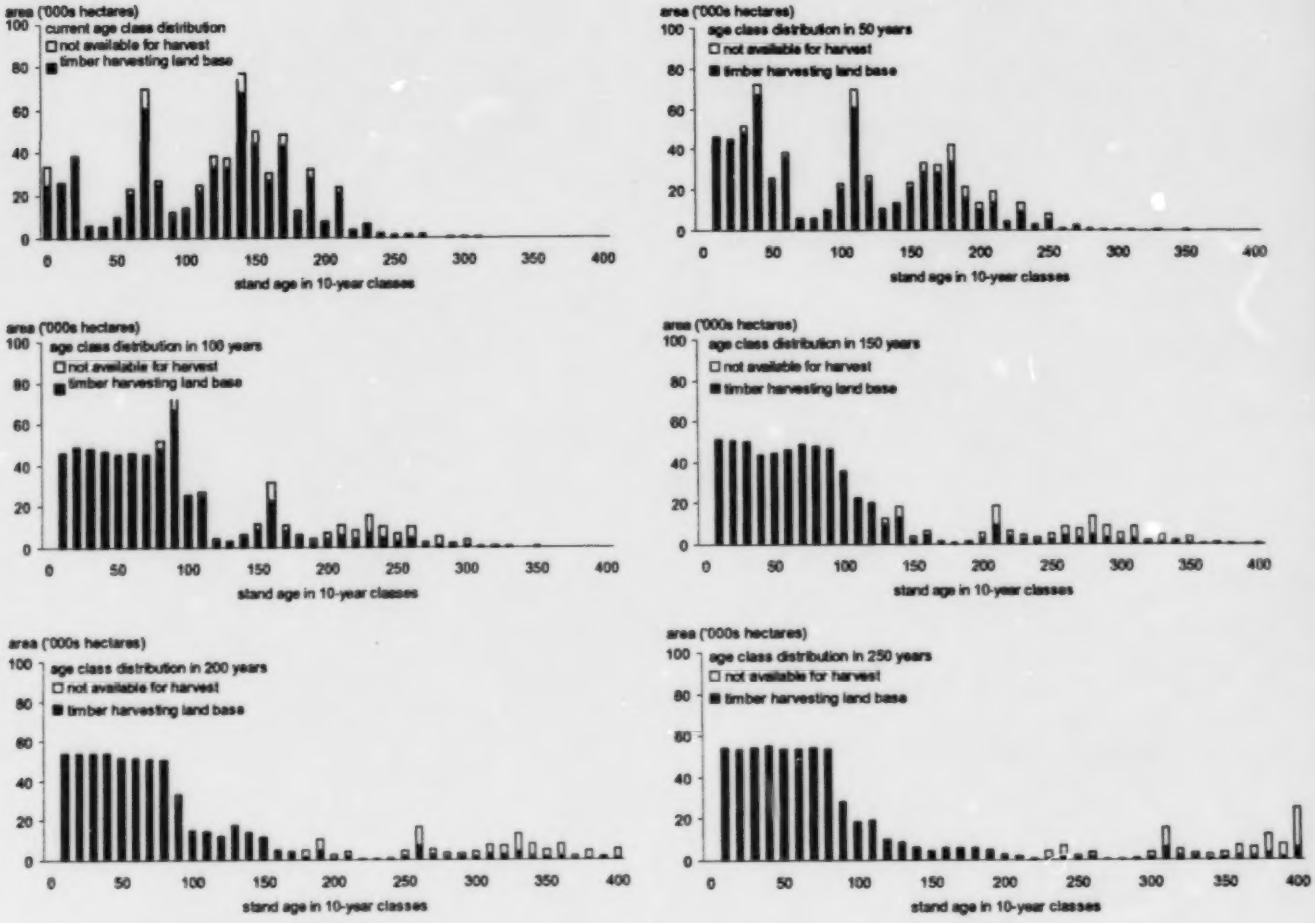
area ('000s hectares)
current age class distribution
not available for harvest
timber harvesting land base
stand age in 10-year classes
age class distribution in 50 years
age class distribution in 100 years
age class distribution in 150 years
age class distribution in 200 years
age class distribution in 250 years

Figure 13. Distribution of age classes for the productive forest area at 50 year intervals — Lakes TSA base case harvest forecast, 2001.

5 Timber Supply Sensitivity Analyses

The best available information on forest inventories and management practices is used to analyse the timber supply implications of continuing with current management. However, forest management is a complicated and ever-changing endeavor that must account for diverse and changing human values, the dynamics of complex ecosystems, and fluctuating and uncertain economic factors. As well, forests grow quite slowly in terms of human time spans, which means that decisions we make today have not only short-term but also long-term effects. In such a context, we cannot be certain that all data accurately reflect the current state of all values in the forest, how the forest will change, or how our management activities will affect the forest.

One important way to deal with this uncertainty is to revise plans and analyses frequently to ensure they incorporate up-to-date information and knowledge. Frequent planning and decision-making can help minimize any negative effects that may occur if decisions are based on inaccurate information. Frequent revision can also ensure that opportunities that become apparent from new information are not missed.

Another important way of dealing with uncertainty is to assess how values of interest, for example, timber supply, could change if the information used in the analysis is not accurate. Sensitivity analysis is one way of evaluating how uncertainty could affect analysis results, and ultimately decision-making. Sensitivity analysis can highlight that fairly small uncertainties about some variables could have large effects on timber supply projections, or conversely that fairly large inaccuracies in others could have negligible effects. Also, sensitivity analysis could show that some variables affect timber supply more in the short term than in the long term, while others have the opposite effect. Sensitivity analysis can highlight priorities for collecting information for future analyses, and show which variables, and associated uncertainties, have the most significance for decisions. It can clarify whether current best estimates provide a safe basis for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser. In this section, results of several sensitivity analyses are discussed. The results based on current forest management assumptions (shown in Figures 7 to 13) are referred to as the base case. This section presents the results of extensive sensitivity analysis. Detailed results are presented for only four sensitivity analyses with potentially significant impacts. Sensitivity analyses that show little or no effect, or with low risk, are presented in a summary form only.

5.1 Alternative harvest flows over time

The base case harvest forecast shown in Figure 7 was defined using criteria discussed in Section 4.1, "Base case harvest forecast," including avoiding large and abrupt harvest shortfalls, and maintaining a fairly constant growing-stock level over the long term. The second of these criteria is linked to maintaining the productivity of forest land, and is therefore an indicator of sustainability. Application of the other criterion avoids both excessive changes from decade-to-decade, and significant timber shortages in the future, either of which might limit future options. However, there are many possible harvest flows, with different decline rates, starting harvest levels, and potential trade-offs between short- and long-term harvests.

Figure 14 shows two alternatives to the base case harvest forecast. The first alternative maximizes the first period harvest level with a non-declining harvest flow objective (i.e., harvest levels may rise but not fall) while meeting the other criteria used to establish the base case harvest forecast. In this case, the result is an even-flow harvest forecast because it is not possible to increase the long-term harvest level above the short-term harvest level. This alternative shows that the short-term harvest level can be increased immediately by approximately 16% to the long-term harvest level of the base case (1 695 000 cubic metres per year). This is possible because of the large stock of old timber that is available for harvesting, the reduced minimum harvestable ages compared with the 1995 analysis, and the increased timber yield curves resulting from the site index adjustments for regenerated pine stands.

The second alternative maximizes the first decade harvest level with 10% drops per decade without falling below the long-term harvest level. It shows that the first-decade harvest level can be raised as high as 2 093 000 cubic metres per year while meeting the other criteria used to establish the base case harvest forecast. This harvest flow alternative shows that there is considerable flexibility in the first decade harvest level.

The base case harvest forecast was formulated to maintain rather than increase the current harvest level. This makes the base case harvest forecast relatively insensitive to uncertain factors that affect the short- and medium-term harvest levels. The maximum non-declining harvest flow alternative is more sensitive, and more clearly quantifies the timber supply response, to these factors. This alternative harvest forecast was used as the reference for conducting all subsequent sensitivity analysis.

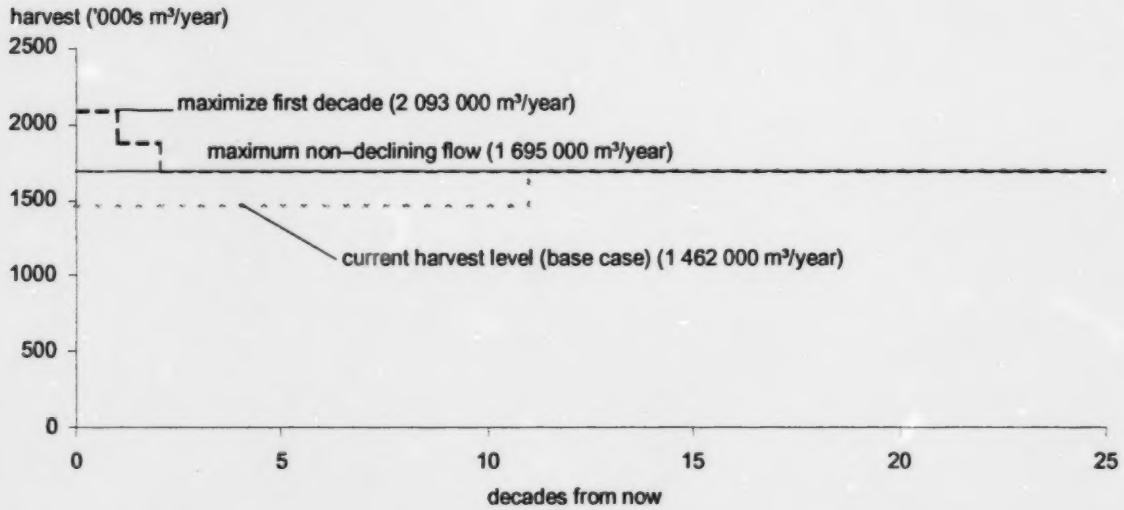

Figure 14. Alternative harvest flow using base case data — Lakes TSA, 2001.

5 Timber Supply Sensitivity Analyses

5.2 Uncertainty in land base available for timber harvesting

Figure 15 shows the sensitivity of the maximum non-declining flow harvest forecast to changes in the size of the timber harvesting land base. If the timber harvesting land base increases by 10% then the harvest level increases by 5% to 1 780 000 cubic metres per year. Increasing the timber harvesting land base decreases the area outside of the timber harvesting land base by the same amount (but not by the same proportion). This means that there is less area outside of the timber harvesting land base to meet forest cover requirements for biodiversity and habitat, particularly old forest requirements. Consequently, more area must be retained as old forest within the timber harvesting land base, causing the increase in harvest level to be less than the increase in the size of the timber harvesting land base.

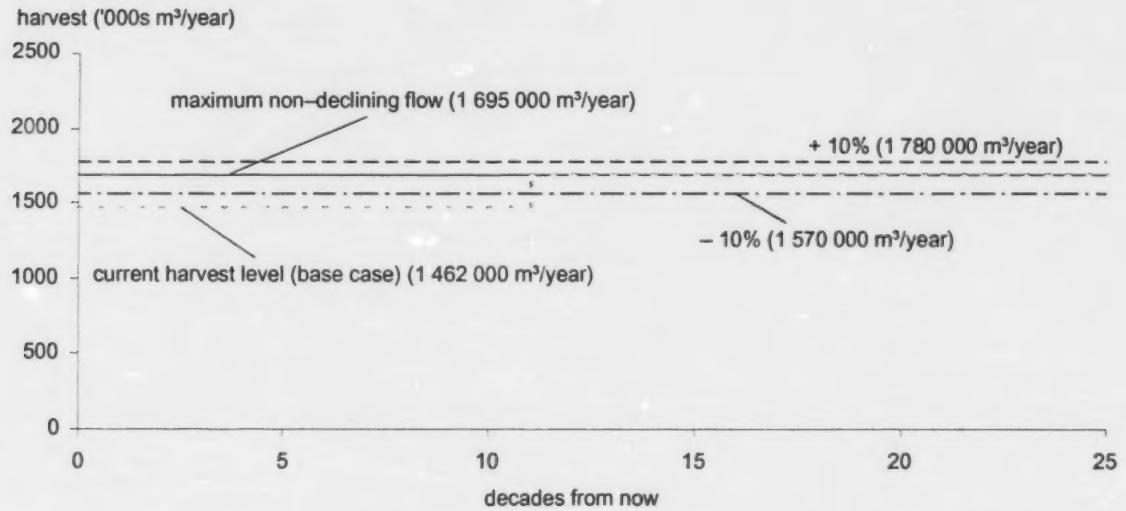

Figure 15. Sensitivity analysis of timber harvesting land base size — Lakes TSA, 2001.

If the timber harvesting land base decreases by 10% then the harvest level decreases by 7% to 1 570 000 cubic metres per year. Decreasing the timber harvesting land base increases the area outside of the timber harvesting land base by the same amount (but not by the same proportion). This means that there is more area outside of the timber harvesting land base to meet forest cover requirements for biodiversity and habitat, particularly old forest requirements. Consequently, less area must be retained as old forest within the timber harvesting land base and this causes the reduction in harvest level to be less than the reduction in the size of the timber harvesting land base.

5 Timber Supply Sensitivity Analyses

Three factors have been identified that might affect the size of the timber harvesting land base. The first factor is the set of criteria used to identify sites with low timber growing potential. For the base case, the site index was determined at which stands reach a minimum volume of 140 cubic metres per hectare by age 160 years for pine stands, and by age 200 for other stands. Stands below this site index were removed from the timber harvesting land base. Recent information suggests that the minimum volume used for the base case may be too low; a volume of 170 cubic metres per hectare instead of 140 cubic metres per hectare may better represent the economic threshold. If this change is made, then the site index criteria increase by 0.9 to 1.2 metres, depending on species. The area with low timber growing potential increases by 12 348 hectares or 95%, but there is a corresponding decrease in the area of problem forest types, so there is no net change in the base case timber harvesting land base. Therefore, this factor has no effect on the harvest forecast.

The second factor that might affect the size of the timber harvesting land base is the set of criteria used to identify problem forest types, specifically low-height pine stands. For the base case, the site index was determined at which pine stands reach a minimum height of 17.5 metres by age 140 years. Recent information suggests that the minimum age could be increased from 140 years to 200 years. If this change is made then the site index criterion for low-height pine decreases by 1.8 metres and the area of low-height pine decreases by 13 537 hectares or 85%. This causes a slight decrease in the deduction for existing roads and a slight increase in the deduction for riparian areas, so there is a net increase in the base case timber harvesting land base of 12 554 hectares or 2.1%.

There is some balancing of effects between the criteria for identifying sites with low timber growing potential and the criterion for low-height pine stands. There is a net increase in the base case timber harvesting land base of 9390 hectares or 1.6%.

The third factor that might affect the size of the timber harvesting land base is the amount of old-growth management areas (OGMA) required within the timber harvesting land base. Completion of landscape unit planning by July 2002 will verify land base reductions for old-growth management areas.

5.3 Uncertainty in site productivity estimates for pine

Most existing lodgepole pine stands in the Lakes TSA were established following fire. These stands regenerated with very high densities (i.e., number of trees per hectare). High density causes extreme competition among individual trees and results in a reduction in height growth compared with less dense stands growing on the same site. This height repression, which is observed as a low site index or estimate of site productivity, affects the volume growth of a stand. When these natural stands are harvested and regenerated as managed stands, the density of planted trees is much lower than the density of natural regeneration following fire. Consequently, there is less competition among individual trees and their height growth fully reflects the natural productivity of a site.

This effect has been confirmed in recent research by Goudie (1996). This study used a paired-plot approach to compare the site index of adjacent natural and managed stands. The result of the study was a set of equations for adjusting site index within the sub-boreal spruce (SBS) biogeoclimatic zone. Because this was a local study, these adjustments were used in the base case. However, site index was not adjusted within the following special management areas: the very high value component of the caribou migration corridor, backcountry lakes, the strong link component of the biodiversity ecosystem network, and retention VQOs. These areas have restrictive forest cover requirements and regenerated stands are not expected to achieve the paired-plot site index. Table 5 shows the site productivity estimates for pine stands before and after adjustments.

Table 5. Site productivity estimates for pine — Lakes TSA, 2001.

			Adjusted site index[a]	
Species group	**Productivity class**	**Current site index**	**SBS mc2**	**SBS dk**
Pure pine	Good	19.2	20.0	21.8
	Medium	14.9	20.0	20.1
	Poor	11.5	20.0	18.8
Pine spruce	Good	19.2	20.0	21.8
	Medium	15.0	20.0	20.1
	Poor	11.6	20.0	18.8

(a) From Goudie (1996).

The site index adjustments used in the base case reflect the maximum potential productivity of sites for growing lodgepole pine. Managed stands will have their density controlled to avoid height repression caused by high density. However, the actual productivity achieved may still be less than estimated as a result of factors that reduce height growth, such as top damage by insects or wind. This causes uncertainty about the site productivity estimates for pine used in the base case. The uncertainty may be tempered by the higher operational adjustment factor used in this analysis to account for the effect of pine stem rusts.

5 Timber Supply Sensitivity Analyses

Figure 16 shows the effect on the maximum non-declining harvest forecast if only half of the estimated increase in site productivity for pine is realized. The short-term harvest level can be maintained for five decades. The harvest level falls 10% in decade six and 5% in decade seven to reach a long-term harvest level of 1 450 000 cubic metres per year.

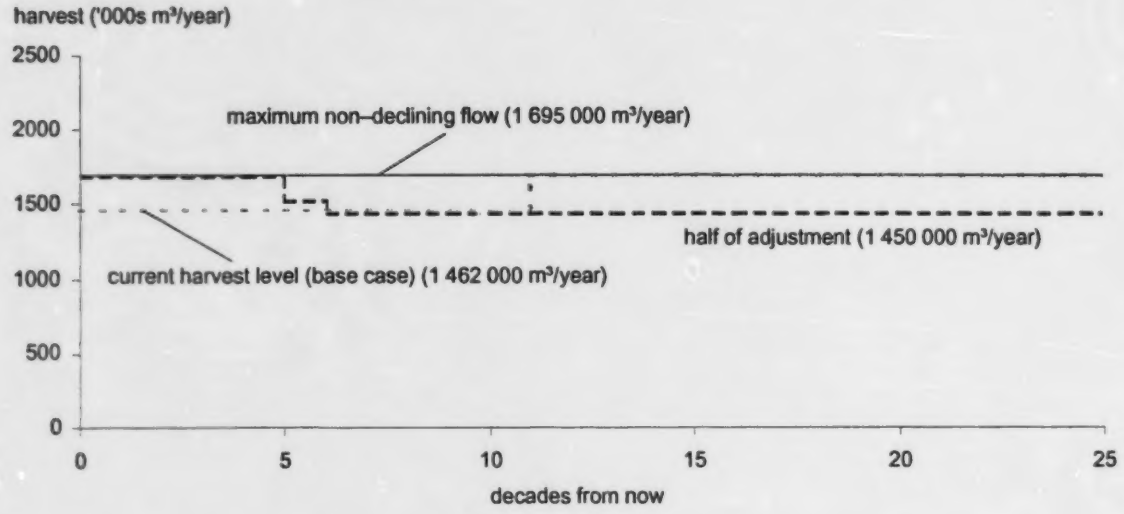

Figure 16. Sensitivity analysis of site productivity of pine stands — Lakes TSA, 2001.

Adjusting site productivity affects height growth, which influences three factors: timber volumes, green-up periods and minimum harvestable ages. To determine the importance of each factor, another sensitivity analysis considered only the volume effects of applying half of the increase in site productivity for pine, (i.e., the lower green-up periods and minimum harvestable ages from the base case are used). In this case, the harvest forecast is similar except that the long-term harvest level increases slightly by 10 000 cubic metres per year, or 1%, to 1 460 000 cubic metres per year. This indicates that the major effect of uncertainty in site productivity is caused by the change in timber volumes. The change in green-up periods and minimum harvestable ages are not a significant factor (see Section 5.5, "Sources of uncertainty with little or no sensitivity").

5.4 Uncertainty in site productivity estimates for older spruce, fir and balsam stands

Estimating the future productivity of sites currently occupied by existing old-growth forest is difficult in that it is not possible to know with certainty how the productivity of a regenerated stand will compare to the productivity of the existing stand it replaces. The productivity of a site largely determines how quickly trees will grow. It therefore affects the timber volumes in regenerated stands, the time to reach green-up and the age at which those stands will reach merchantable size. The most accurate estimates of site productivity come from stands between 30 and 150 years old. At ages less than about 30 years a temporary increase or decrease in growth due to factors such as a post-harvest flush of nutrients or an unusual drought year can affect the overall productivity estimated for the stand. At older ages, site productivity estimates may be inaccurate because tree heights do not represent actual production — for example due to top breakage — and it is very difficult to determine ages of old trees accurately.

In the Lakes TSA the problem of uncertainty in site productivity estimates for older stands (i.e., greater than 140 years in age) only applies to spruce, fir and balsam stands. Pine stands have their productivity adjusted separately, as described in Section 2.4.2, "Timber growth and yield changes" and Section 5.3, "Uncertainty in site productivity estimates for pine." The results of recent province-wide research suggest that the estimated productivity of sites currently occupied by old-growth stands may be significantly underestimated. A paired-plot study (Nussbaum 1998) compared the site index of old-growth stands with adjacent logged- and regenerated-stands. Equations for adjusting site index were developed for coastal Douglas-fir, lodgepole pine and interior spruce. A veteran tree study (Nigh 1998) developed site index adjustment equations for species not covered by the paired-plot study. The veteran study used temporary and permanent sample plots with a veteran and a main stand component. The results of the veteran study are considered less reliable than the paired plot study. Table 6 shows the site productivity estimates for old spruce, and fir/balsam stands before and after adjustments derived using these studies.

Table 6. Site productivity estimates for old spruce and fir/balsam — Lakes TSA, 2001

Species group	Productivity class	Current site index	Adjusted site index
Spruce	Good	20.1	21.2
	Medium	15.7	20.1
	Poor	11.1	19.3
Fir/balsam	—	11.8	14.4

5 Timber Supply Sensitivity Analyses

The site index of old spruce stands was adjusted after regeneration using the results of the paired-plot study. Old spruce stands account for approximately 10% of the timber harvesting land base. The site index of balsam and interior Douglas-fir stands was adjusted after regeneration using the veteran study. Old fir/balsam stands account for approximately 2% of the timber harvesting land base. Figure 17 shows the effect on the maximum non-declining harvest forecast of applying these adjustments. With the adjustments, the harvest level can be increased by 4% to a non-declining level of 1 765 000 cubic metres per year.

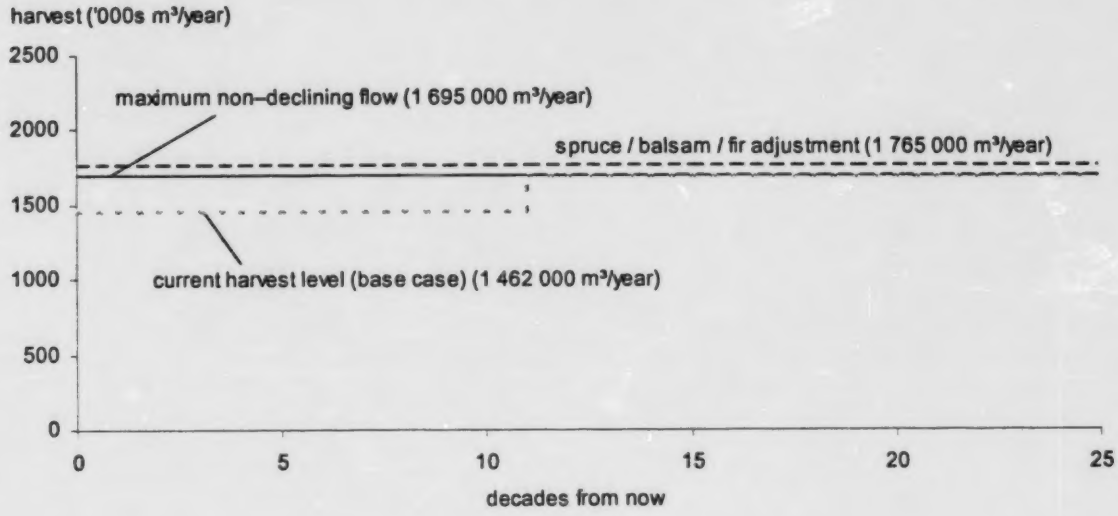

Figure 17. Sensitivity analysis of site productivity estimates in older spruce, fir and balsam stands — Lakes TSA, 2001.

Applying the site index adjustments affects three factors. First, green-up periods across the TSA decrease very slightly by 0 to 1 years (an exception is the green-up period for grizzly habitat, which decreases by 3 years). Second, minimum harvestable ages decrease by 7 years in spruce stands with good productivity, 25 years in spruce stands with medium productivity, 63 years in spruce stands with poor productivity, and by 20 years for fir/balsam stands. This factor also has little timber supply impact because minimum harvestable ages are generally not a limiting factor. Third, timber volume estimates for the old stands increase, with the greatest increase occurring in stands with poor productivity. This factor accounts for most of the increase shown in Figure 17 because of the minimal impact of the other two factors. Old spruce and fir/balsam stands account for only 12% of the timber harvesting land base, so the total impact is small.

5.5 Sources of uncertainty with little or no sensitivity

The maximum non-declining harvest forecast showed little or no sensitivity to several sources of uncertainty (less than or equal to 4%). These sources and the results of the sensitivity analysis are summarized in Table 7. Explanatory notes for some of these sensitivity analyses are provided below.

Two factors have been identified that might increase minimum harvestable ages. First, the minimum volume of 170 cubic metres per hectare may reflect actual economic thresholds better than 140 cubic metres per hectare. This would increase the minimum harvestable age by less than 10 years, which has no effect on the maximum non-declining harvest forecast. Second, if only one-half of the expected increase in site productivity for managed pine stands is realized, then some minimum harvestable ages for pine would increase by 1 to 2 years on good sites, 10 to 11 years on medium sites, and 20 years on poor sites (7% of pine stands). Sensitivity analysis showed that increases of up to 10 years have no effect and increases of up to 20 years have only a very slight effect on the short- and medium-term harvest levels.

Uncertainty in green-up periods was quantified for three different estimates that reduced green-up periods. All three of these estimates fall within the range of reduced green-up ages tested (see Table 7):

- The green-up requirements in the *Green-up Guidebook* changed from average height (silviculture height) to the height of the tallest trees in a stand (top height).
- Two studies on early height growth in pine (Nigh and Love 1999) and spruce (Nigh and Love 2000) showed reduced time to reach green-up heights.
- A study that summarized green-up ages from the Ministry of Forests's database for the Integrated Silviculture Information System (ISIS) (B.C. Ministry of Forests 2000).

Effects of uncertainty in forest cover requirements for adjacency were tested for the following reasons:

- To find the levels of maximum non-greened-up area that do not affect the harvest forecast. Harvest levels were affected only when the maximum non-greened-up area fell below the minimum level tested (20%).
- Staff of the Ministry of Forests (MoF) and the Ministry of Environment, Lands and Parks (MELP) in the Lakes Forest District believe that there is a risk of fragmentation over the landscape which could result in loss of existing interior forest conditions. This would be detrimental to landscape-level biodiversity. Consequently, tenure holders have been encouraged to plan larger blocks and amalgamate existing fragmented patches by harvesting within unharvested second- and third-pass areas. Green-up requirements have been waived in these situations where appropriate. The impact of approving larger block sizes was tested by increasing the maximum allowable non-greened-up area from 33% to 40% for the IRM zone.

5 Timber Supply Sensitivity Analyses

Table 7. Summary of sensitivity analyses with little or no effect on the maximum non-declining harvest forecast — Lakes TSA, 2001

Source of uncertainty	Sensitivity analysis	Effect on maximum non-declining harvest forecast
Minimum harvestable age	Increase or decrease by 10 years	No change.
	Increased by 20 years	Reduce harvest level for decades 1-15 by 0.3% or 5000 cubic metres per year. No change to long-term harvest level.
Volume estimates for old stands	Capped after 250 years	No change.
Maximum allowable disturbance for VQOs	Top of class	Entire forecast increased by 1.5% or 25 000 cubic metres per year.
	Mid-point of class	Reduce long-term harvest level by 1.5% or 25 000 cubic metres per year from decade 14 onward.
	Corrected discrepancy in base case	Reduce long-term harvest level by 1.8% or 30 000 cubic metres per year from decade 13 onward.
Green-up period	Increased by 5 years	Reduce long-term harvest level by 1.5% or 25 000 cubic metres per year in decade 10.
	Decreased by 5 years	Entire forecast increased by 1.8% or 30 000 cubic metres per year.
Adjacency	Maximum 20% to 40% non-greened-up	No change.
Age of old forest characteristics	Age of old forest increased or decreased by 20 years	No change.
Aging of stands outside timber harvesting land base	Revert stands at age 300 or 250 years to zero	Reverting stands at age 300 reduces medium- and long-term by 3%, and age 250 reduction is 4%.
Old-growth representation	Site series level using surrogates developed by Lakes Forest District staff	No change.

5.6 Sources of uncertainty with low risk

Several standard sensitivity analyses were conducted for a number of factors. These sensitivity analyses showed significant potential impacts on the maximum non-declining harvest forecast. However, there was no evidence to indicate that any of the factors were incorrectly estimated for the base case. The results of these sensitivity analyses are summarized in Table 8. Explanatory notes for some of these sensitivity analyses are provided below.

- Minimum harvestable ages — some minimum harvestable ages are up to 30 years lower than in the 1995 analysis, which used culmination age criteria instead of minimum merchantable volume criteria.
- Timber volume estimates for existing unmanaged stands — an audit of the forest inventory in the Lakes TSA completed in 1999 indicates that operable timber volumes may be overestimated by 1% and this overestimate is not statistically significant (B.C. Ministry of Forests 1999).
- Timber volume estimates for managed stands — the effect of site productivity estimates on timber volume estimates is discussed in Section 5.3, "Uncertainty in site productivity estimates for pine," and Section 5.4, "Uncertainty in site productivity estimates for older spruce, fir and balsam stands."

Table 8. Summary of sensitivity analyses for factors with little uncertainty — Lakes TSA, 2001

Source of uncertainty	Sensitivity analysis	Effect on maximum non-declining harvest forecast
Minimum harvestable age	Increased by 30 years	Reduce harvest level for decades 1 to 15 by 4.4% or 75 000 cubic metres per year. Reduce long-term harvest level by 0.6% or 10 000 cubic metres per year in decade 16.
Timber volume estimates for existing unmanaged stands	Increased by 10%	Increase harvest level in decades 1 to 10 by 10% or 170 000 cubic metres per year. No change to long-term harvest level.
	Decreased by 10%	Reduce harvest levels for decades 1 to 10 by 6% or 95 000 cubic metres per year. No change to long-term harvest level.
Timber volume estimates for regenerated (managed) stands	Increased by 10%	Increase harvest levels in decades 1 to 11 by 5% or 85 000 cubic metres per year. Increase long-term harvest level by 10% or 170 000 cubic metres per year.
	Decreased by 10%	Reduce long-term harvest level by 10% or 170 000 cubic metres per year in decade 9.

6 Critical Issue Analysis — Mountain Pine Beetle Outbreak

Sensitivity analysis is used to evaluate uncertainty about the accuracy of information used in the timber supply analysis. Results of sensitivity analysis are discussed in Section 5, "Timber Supply Sensitivity Analyses." However, there may also be issues with fundamental assumptions used in the analysis. These types of uncertainties are usually large and quantifiable, rather than being an issue of accuracy of an estimated factor.

Critical issue analysis is distinguished from sensitivity analysis to highlight the importance of the issue being examined. One critical issue exists for the Lakes TSA — an outbreak of mountain pine beetle.

6.1 Description of mountain pine beetle outbreak

The mountain pine beetle (MPB), *Dendroctonus ponderosae* Hopkins (Coleoptera: Scolytidae), is the most damaging insect attacking lodgepole pine in western Canada[1]. This beetle attacks susceptible host trees in the early summer, and kills them by the summer of the following year. It accomplishes this through a combination of larval feeding and introduction of a pathogenic fungus. These two actions effectively girdle the tree, and kill it. Susceptible stands are largely comprised of even-aged lodgepole pine greater than 100 years old although younger stands to 60 years may also be attacked. As previously noted, 76% of the timber harvesting land base in the Lakes TSA is covered by pine-leading stands, of which 77% is older than 60 years.

Outbreaks of mountain pine beetle in northern regions generally last about 10 to 12 years. The last large outbreak in B.C. took place during the late 1970s to mid-1980s in the Cariboo Forest Region. It covered approximately 400 000 hectares in the Chilcotin Forest District, and timber from this infestation is still being harvested.

In the Prince Rupert Forest Region, a large proportion of the region's MPB infestation is located in the Lakes TSA. In 1995, the volume affected by the MPB in the Lakes TSA was estimated to be about 100 000 cubic metres. By 2000, this volume increased to over 1 900 000 cubic metres. The building of the infestation since 1995 is partially attributable to abundant host material and a series of mild winters conducive to high overwintering survival of the MPB larvae. In addition, the proximity of a large infestation in Tweedsmuir Park has allowed for buildup of populations adjacent to the TSA. Since 1998 infested volumes have doubled each year.

If the current rate of spread continues, Lakes Forest District staff estimate that the total volume of pine attacked in all stands in the timber harvesting land base could be as high as 19 million cubic metres in the first 5 years (3.8 million m^3/year) and 34 million cubic metres in the second 5 years (6.8 million m^3/year). The outbreak is expected to last approximately 10 years and will affect about 70% of the pine volume in the timber harvesting land base.

Given the importance of the forest industry to Burns Lake, and the large percentage of lodgepole pine in the timber profile, the current MPB epidemic represents a serious threat to the medium and long-term economic viability of the area.

In spite of the B.C. Forest Service implementing one of the most intensive treatment programs in the province — with the goal of reducing the spread of MPB — the problem and its impact on all resource values continues to increase. This places the future timber supply for the Lakes TSA in jeopardy since such a large component of the TSA is comprised of susceptible lodgepole pine.

There is also an outbreak of spruce bark beetle that is affecting spruce trees. An aggressive salvage program in spruce is expected to harvest an average of 430 000 cubic metres per year in the first 5 years and 50 000 cubic metres per year thereafter. This would result in no additional unsalvaged losses due to spruce bark beetle.

(1) There are other bark beetles in the area, such as spruce beetle (*Dendroctonus rufipennis*) and western balsam bark beetle (*Dryocoetes confusus*), however at present the mountain pine beetle is considered the most damaging.

In order to address the MPB problem in an expedient manner and reduce both long- and short-term impacts, the District Manager has requested an AAC increase of 1.5 million cubic metres for the control of the MPB and salvage of beetle attacked stands. This increase is based on staff estimates that a maximum of 3.0 million cubic metres per year can be harvested according to existing and estimated future milling capacity in the region. After accounting for the spruce volumes affected by the spruce bark beetle, this provides for a pine harvest of 2.57 million cubic metres in the first five years of the first decade and 2.95 million cubic metres in the second five years. The attacked pine volumes that would remain unsalvaged amount to 1.23 million cubic metres per year in the first 5 years and 3.85 million cubic metres per year in the second five years.

The assumptions described here define what is thought to be the worst case scenario for the mountain pine beetle outbreak. Figure 18 shows the levels of infestation for the mountain pine beetle to the end of 2000 and the predicted levels of infestation for the mountain pine beetle in 2010 for the worst case scenario.

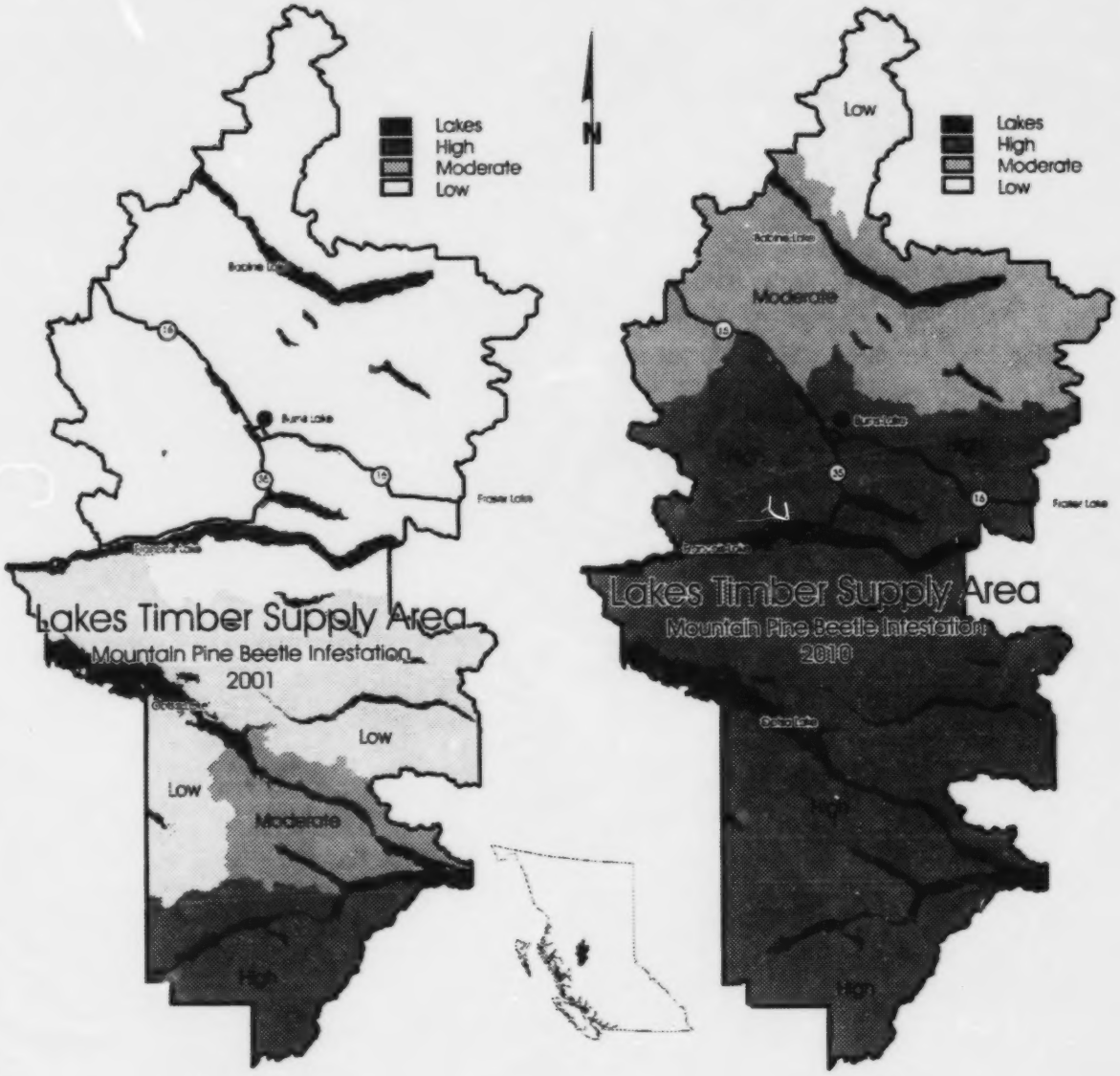

Figure 18. Infestation levels for mountain pine beetle for 2001 and projected for worst case in 2010 — Lakes TSA, 2001.

6.2 Harvest forecast for a worst case infestation

The harvest forecast for the worst case scenario assumed that unsalvaged pine stands would regenerate naturally with a 10-year regeneration delay*. The timber yields were assumed to be those of the existing natural stands instead of the higher yields of managed stands. All forest cover requirements were removed for the first 10 years (i.e., landscape-level biodiversity, wildlife habitat, VQOs, backcountry lakes, recreation areas and adjacency requirements) because the insect attacks would not recognize those requirements. For the first 10 years an unsalvaged loss of 21 176 cubic metres per year was applied to account for the base case level of fire and blowdown losses. The unsalvaged losses for the balance of the 250-year horizon of this forecast are 31 976 cubic metres per year, which is the original estimate of unsalvaged losses used in the base case.

Figure 19 shows the harvest forecast for the worst case scenario. The initial harvest level is 3.0 million cubic metres per year. The harvest level falls 35% after each of decades 1 and 2 to reach a medium-term harvest level in decade 3 of 1 270 000 cubic metres per year. The medium term harvest level is maintained until decade 8. In decade 9, the harvest level rises by 12% to 1 425 000 cubic metres per year. In decade 14 the harvest level rises by 18% to a long-term harvest level of 1 680 000 cubic metres per year, which is less than 1% below the long-term harvest level for the maximum non-declining harvest forecast.

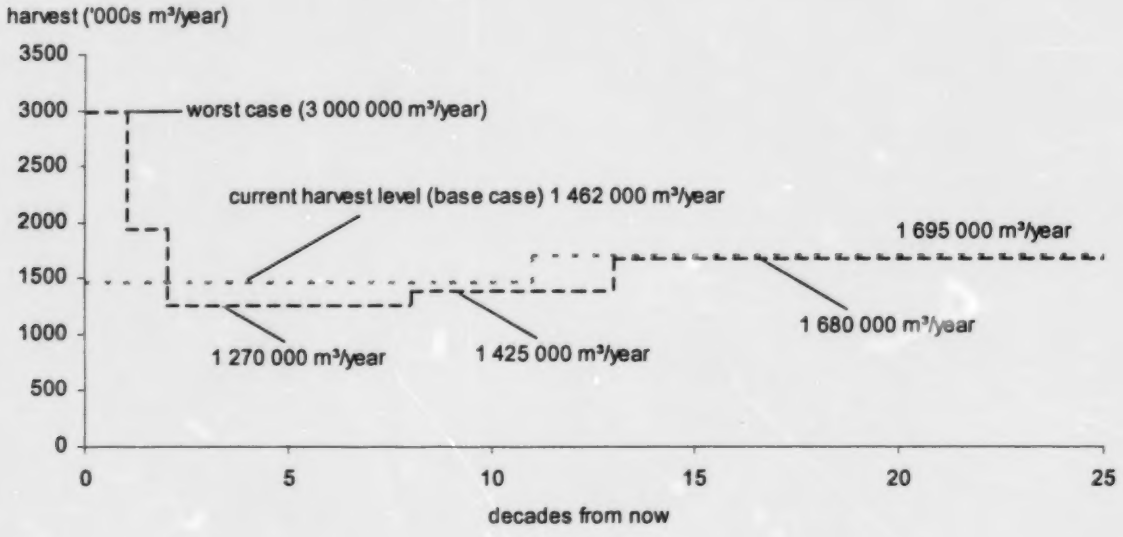

Figure 19. Harvest forecast for worst case scenario of mountain pine beetle outbreak — Lakes TSA, 2001.

The large reductions in decades 2 and 3 are necessary to avoid major shortfalls in decades 7 and 8 caused by gaps in the current age class distribution (see Figure 20 in Section 6.3, "Implications of the worst case infestation"). In the base case, these age class gaps did not cause disruptions in the harvest forecast for two reasons. First, the existing old timber was harvested and converted to young stands at a slower rate, so that there was sufficient existing timber to last until young regenerated stands became available for harvest. In the worst case scenario the existing old timber was

Regeneration delay
The period of time between harvesting and the date at which an area is occupied by a specified minimum number of acceptable well-spaced trees.

converted more quickly, so it is not available to cover the age class gap. Second, the regenerated stands in the base case were managed stands with higher timber yields than the natural stands. In the worst case scenario, approximately one-half of the regenerated stands created during the mountain pine beetle outbreak regenerate naturally with lower yields than the managed stands. This is because the rate of harvest and subsequent reforestation efforts do not keep up with the beetle epidemic.

6.3 Implications of a worst case infestation

Figure 20 shows the contribution to the worst case harvest forecast from existing and managed stands.

Harvesting in managed stands begins in decade 5 following the rapid depletion of existing natural stands during the mountain pine beetle outbreak. The oldest managed stands in decade 5 are about 90 years old. Harvesting in managed stands dips from decade 8 to 11 as a wave of natural stands becomes available. These natural stands regenerated from unsalvaged stands during the mountain pine beetle outbreak. The transition to harvesting entirely in managed stands is almost complete after 14 decades. Existing stands continue to contribute small amounts after decade 14, mostly from areas with restrictive forest cover requirements, such as VQOs, backcountry lakes and recreation areas.

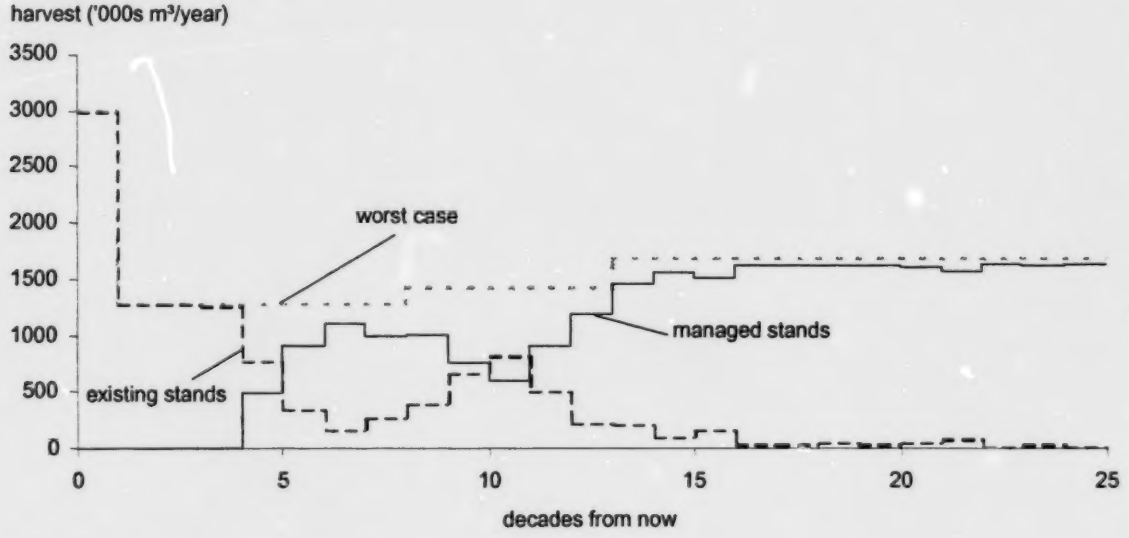

Figure 20. Harvest contributions from managed stands for the worst case mountain pine beetle scenario — Lakes TSA, 2001.

6 Critical Issue Analysis — Mountain Pine Beetle Outbreak

Figure 21 shows growing stock levels for the timber harvesting land base. The total growing stock declines rapidly as a result of harvesting of timber threatened by the mountain pine beetle outbreak. The growing stock reaches a minimum in decade 3 and slowly increases to a stable level by decade 14. The merchantable growing stock levels are similar to the total growing stock levels on the timber harvesting land base because of the low minimum harvest ages used in the timber supply analysis. The growing stock for managed stands grows quickly until decade 5, after which it flattens as a result of heavy harvesting in managed stands. It grows again during decades 9 to 11 when harvesting is concentrated in the natural stands that regenerated following the mountain pine beetle outbreak. The growing stock for managed stands increases rapidly until decade 5, after which it flattens as a result of heavy harvesting in managed stands.

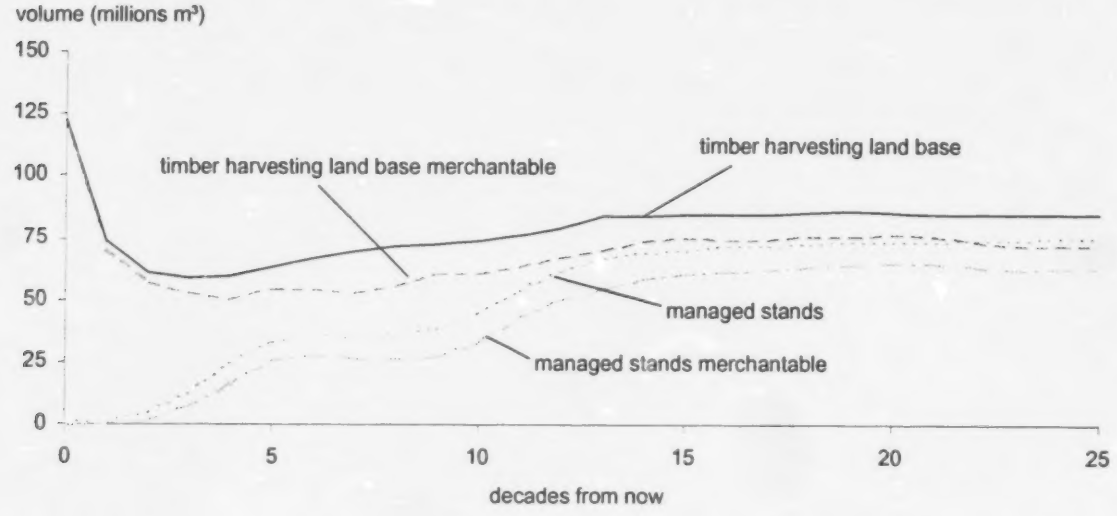

Figure 21. Timber growing stock forecasts for the worst case mountain pine beetle scenario — Lakes TSA, 2001.

6 Critical Issue Analysis — Mountain Pine Beetle Outbreak

Figure 22 shows the average annual area harvested and the average volume per hectare harvested in each decade. The average annual yield drops from an initially high level as harvesting moves quickly into young stands following the mountain pine beetle outbreak. It reaches a minimum of 180 cubic metres per hectare in decade 10, then rises again as managed stands age and harvesting occurs in older stands again. The average annual area harvested drops precipitously from almost 12 000 hectares in the first decade during the outbreak to a low of almost 4200 hectares in decade 3. It rises again as young stands with lower yields are harvested then declines again as the managed stands age and achieve higher yields. In decade 14, the harvest level increases to the long-term harvest level, and the average annual area harvested stabilizes around 6450 hectares.

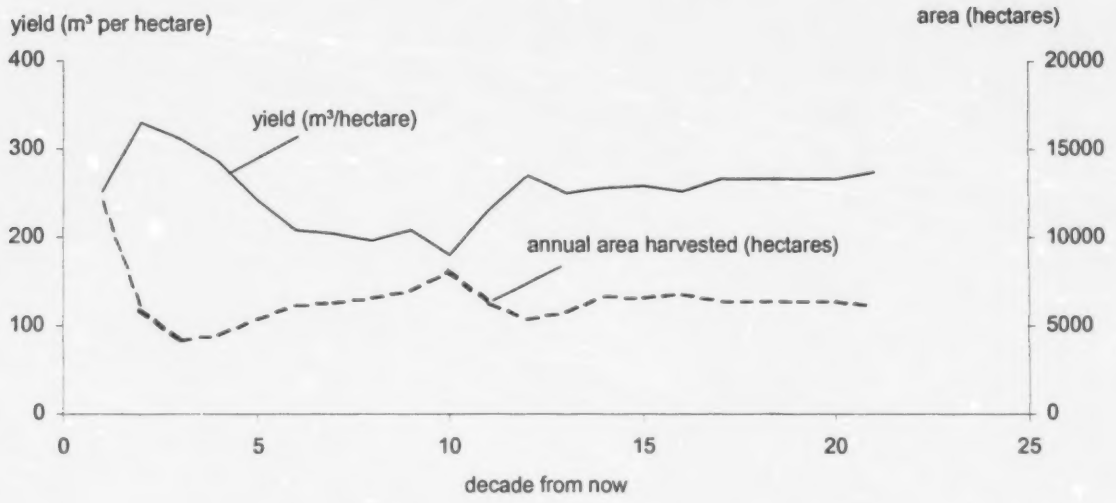

Figure 22. Average volume yield and average annual area harvested for the worst case mountain pine beetle scenario — Lakes TSA, 2001.

6 Critical Issue Analysis — Mountain Pine Beetle Outbreak

Figure 23 shows the average age (weighted by area) of the stands harvested in each decade by management emphasis. The average harvest age generally declines as a result of the transition from harvesting old existing stands to younger managed stands. As for the base case, the only exception is in the backcountry lakes where the restrictive management requirements limit harvesting to such an extent that timber continues to grow older. However, the average ages are considerably lower than in the base case as a result of the rapid salvage of attacked existing natural stands, and the early harvesting in managed stands. In particular, the average harvest age in the IRM and habitat areas falls to a minimum of 55 to 60 years in decade 7 before slowly increasing. The average harvest age of zero in the caribou migration corridor during decades 2 to 4 indicates that no harvesting occurs in that zone during those decades. This occurs because so much timber is harvested during the mountain pine beetle outbreak that forest cover requirements prohibit harvesting immediately following the outbreak. The average harvest age in the long term is lower than in the base case. For the IRM zone in particular, it is around 75 years compared to 100 years in the base case.

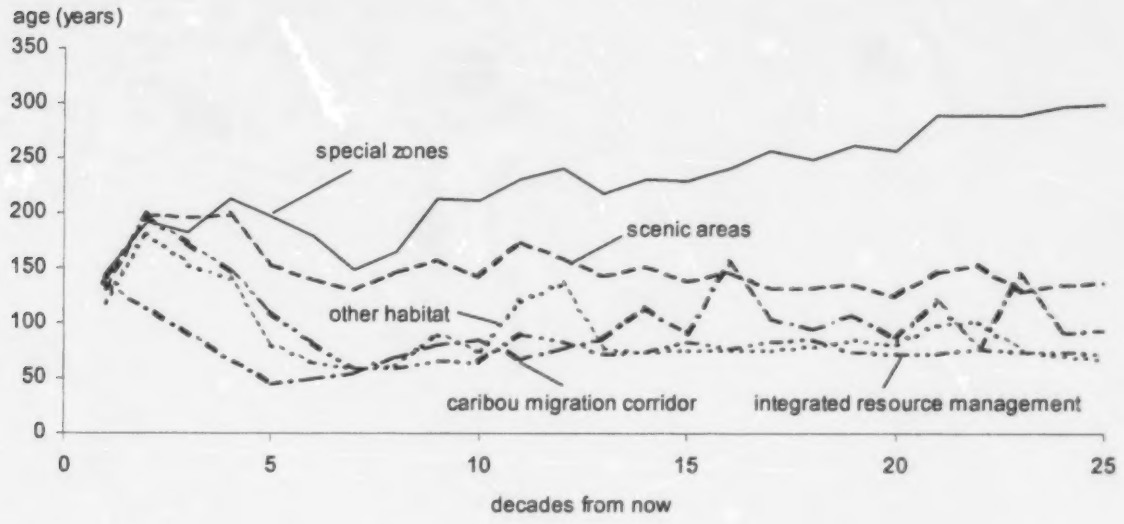

Figure 23. Average area-weighted harvest age for the worst case mountain pine beetle scenario — Lakes TSA, 2001.

The charts in Figure 24 show how the distribution of age classes in the productive forest is projected to change under the harvest forecast for the worst case mountain pine beetle scenario. The current age class distribution for the timber harvesting land base has two significant gaps in the 30 to 50 year age classes and in the 90 to 100 year age classes. Unlike the base case, these gaps do cause disruptions in timber supply. They are the factor that limits the harvest level in decades 7 and 8. This occurs because the rapid depletion of old timber during the mountain pine beetle outbreak leaves insufficient timber available above minimum harvestable age by the end of decade 6. This developing situation is clearly shown at year 50 in Figure 24.

The second main feature of the age class distribution can also be seen at year 50 in Figure 24. This shows a very large area between 31 and 50 years old that was established during the mountain pine beetle outbreak. By year 100, a large part of this age cohort has been harvested and it disappears completely by year 150. By year 200 the age class distribution has stabilized with relatively even area in the timber harvesting land base below 70 years.

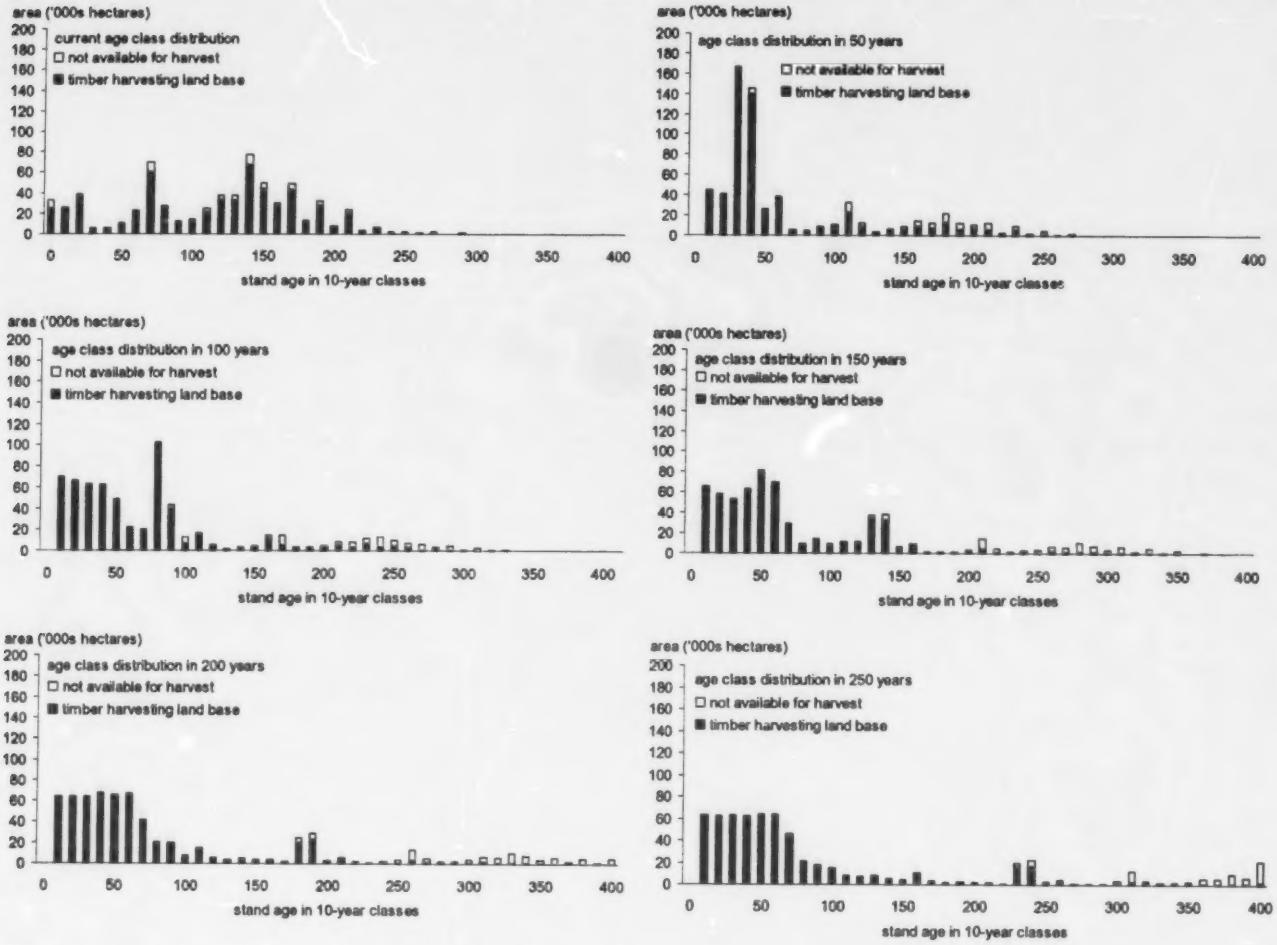
area ('000s hectares)
current age class distribution
not available for harvest
timber harvesting land base
stand age in 10-year classes
age class distribution in 50 years
age class distribution in 100 years
age class distribution in 150 years
age class distribution in 200 years
age class distribution in 250 years

Figure 24. Distribution of age classes for the productive forest area at 50 year intervals for the worst case mountain pine beetle scenario — Lakes TSA, 2001.

6.4 Uncertainty in size of the mountain pine beetle outbreak

It is possible that aggressive harvesting or changes in weather patterns will limit the spread of the mountain pine beetle outbreak. A moderate scenario for the mountain pine beetle outbreak assumed that the level of attack for the first five years continues for the second five years, instead of increasing. Under this scenario the unsalvaged pine volume in the second five years would decrease to 450 000 cubic metres per year (total unsalvaged volume of 2.25 million cubic metres) from 3.85 million cubic metres per year under the worst case scenario (total of 19.25 million cubic metres). Figure 25 shows the harvest forecast for this scenario. The initial harvest level is 3.0 million cubic metres per year, but the decline is less drastic. The harvest level declines at a maximum of 20% per decade until the medium-term harvest level of 1 410 000 cubic metres per year is reached in decade 5. This decline is required to avoid major shortfalls in decades 7 and 8, which are again caused by gaps in the current age class distribution. In decade 9 the harvest level rises by 3% to 1 450 000 cubic metres per year. In decade 14 the harvest level rises by 16% to a long-term harvest level of 1 680 000 cubic metres per year, which is the same as under the worst case scenario.

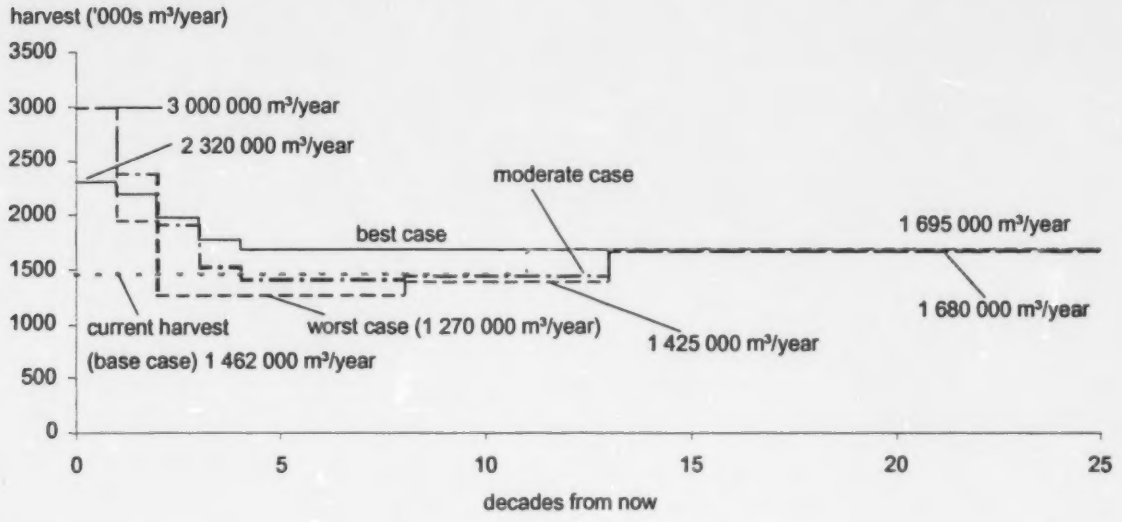

Figure 25 Sensitivity analysis of uncertainty in size of mountain pine beetle outbreak — Lakes TSA, 2001.

A best case scenario assumed that a severe winter in 2001-2002 would stop the mountain pine beetle outbreak, leaving a very limited amount of beetle-killed timber to harvest. The volume of pine attacked would be 3.125 million cubic metres, or 625 000 cubic metres per year for the first five years. This volume was assumed to come entirely from the caribou migration corridor, where the outbreak is currently concentrated. Figure 25 shows the result of the best case scenario. The figure shows a first decade harvest level of 2 320 000 cubic metres per year (although this was actually only applied in the first 5-year period). The harvest level in the second 5-year period was 5% lower at 2 204 000 cubic metres per year. The harvest level subsequently declines at a maximum rate of 10% per decade to the base case long-term harvest level of 1 695 000 cubic metres per year. The affected timber in the caribou migration corridor could be harvested without violating any forest cover constraints.

6 Critical Issue Analysis — Mountain Pine Beetle Outbreak

Table 9 compares the total pine volume attacked and unsalvaged in each five-year period under each mountain pine beetle outbreak scenario. The small amount of unsalvaged loss shown for the best case scenario in years 6-10 represents the normal level of unsalvaged loss attributed to endemic levels of mountain pine beetle.

Table 9. Total pine volumes attacked and unsalvaged for each mountain pine beetle outbreak scenario — Lakes TSA, 2001

	Total pine volume (millions of cubic metres)					
	Attacked			Unsalvaged		
Scenario	Years 1-5	Years 6-10	Total	Years 1-5	Years 6-10	Total
Best case	3.12	0.05	3.17	0.0	0.05	0.05
Moderate	19.0	19.0	38.0	6.15	2.25	8.4
Worst	19.0	34.0	53.0	6.15	19.25	25.4

6.5 Uncertainty in merchantability of attacked stands

There is uncertainty about the length of time that attacked trees will remain in a merchantable condition. The worst case scenario assumes that all attacked stands that remain unharvested immediately become an unsalvaged loss in the 5-year period in which they are attacked. In other words, attacked trees will last less than five years. However, trees may remain merchantable for 10 years after being killed by the mountain pine beetle. The total unharvested amount in the first decade for the worst case scenario would amount to 25.4 million cubic metres, which is more than can be harvested in decade 2, even with the higher harvest levels of the moderate case scenario. If the unharvested amount in the first 5-year period is considered an unsalvaged loss and only the unharvested amount from the second 5-year period remains standing, then 19.25 million cubic metres or approximately 55% of the attacked stands could be harvested in decade 2. This attacked timber could account for up to 82% of the pine harvest of 2.35 million cubic metres per year (after accounting for the spruce harvest of 50 000 cubic metres per year) with the harvest levels of the moderate case scenario. This has two potential effects. First, less harvesting would occur in existing, healthy stands in decade 2, which will leave more old timber standing to help overcome the age class gap in decades 7 and 8. Second, these salvaged stands can be planted so that they will become managed stands with higher yields than natural stands, which will also mitigate the age class gap.

6 Critical Issue Analysis — Mountain Pine Beetle Outbreak

Figure 26 shows the harvest forecast that results if attacked stands in the second 5-year period remain merchantable for 10 years. It shows a maximum decline of 20% per decade with a medium-term harvest level of 1 470 000 cubic metres per year. This medium-term level is slightly higher than the current AAC attributable to the TSA, of 1 462 000 cubic metres per year. It may also be possible to increase the harvest level in decade 2 to salvage attacked timber from the first 5-year period, which should have further beneficial effects by planting these stands instead of allowing them to regenerate naturally. However, this possibility was not tested.

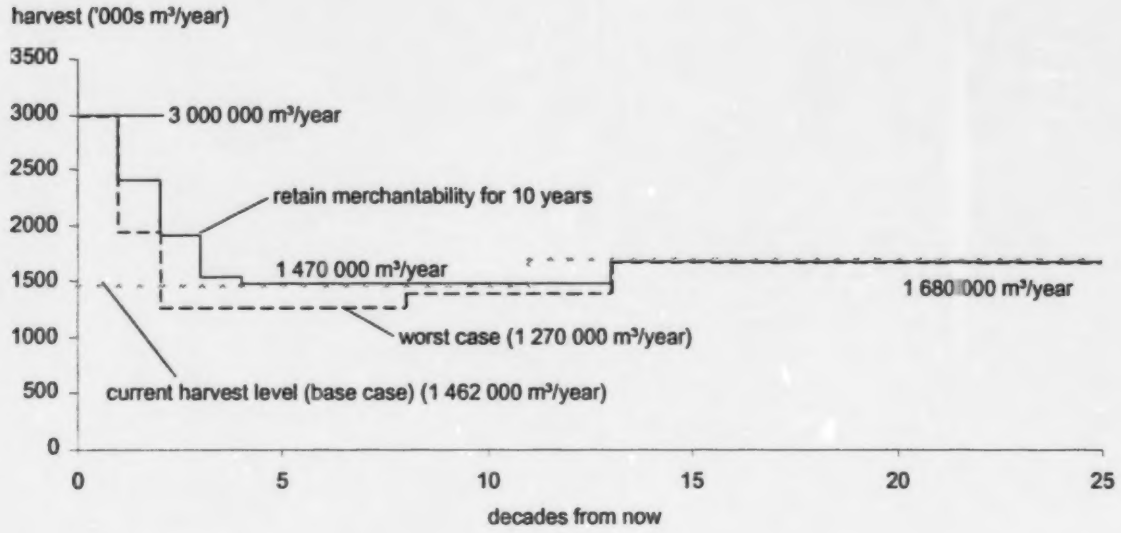

Figure 26. Sensitivity analysis of uncertainty in merchantability of attacked stands for the worst case mountain pine beetle scenario — Lakes TSA, 2001.

6.6 Uncertainty in regeneration of attacked stands

There is uncertainty about the length of time that attacked stands will take to regenerate. The worst case scenario assumed a regeneration delay of 10 years. Reducing the regeneration delay to 5 years allows the mid-term harvest level to increase by 1% to 1 280 000 cubic metres per year. No other significant change occurs.

6.7 Uncertainty in ability to salvage timber

The initial harvest level of 3.0 million cubic metres per year in the worst case scenario may not be achievable. Increasing the harvest levels substantially in the short term requires considerable development of infrastructure (i.e., roads and mills) and boosts in employment in both the primary logging and milling sectors, and in the secondary service sector. Reducing the harvest level after the mountain pine beetle outbreak ends could have negative effects on community stability. There is also uncertainty about the ability of markets to absorb the amount of timber that would be harvested.

A sensitivity analysis examined the impact of reduced harvest levels for the worst case scenario. It was assumed that an initial harvest level of 1.695 million cubic metres per year could be achieved, which is the same level as in the maximum non-declining harvest forecast. Figure 27 shows that the initial harvest level can be achieved but that harvests decline after decade 1 at a maximum rate of 15% per decade. The medium-term harvest level of 1 225 000 cubic metres per year is reached in decade 3. This level is almost 4% below that of the worst case scenario when the initial harvest level was 3 million cubic metres per year. It is maintained for six decades, after which the harvest forecast is the same as for the worst case scenario.

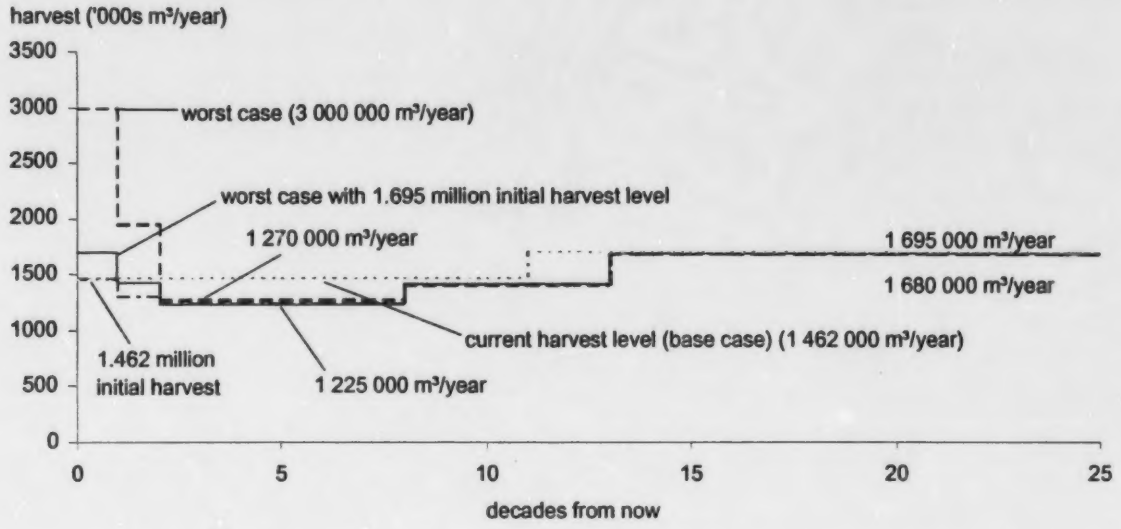

Figure 27. Sensitivity analysis of no additional salvage for the worst case mountain pine beetle scenario — Lakes TSA, 2001.

Figure 27 also shows the harvest forecast when the initial harvest level is the current harvest level of 1 462 000 cubic metres per year. The harvest level falls after decade 1 at a maximum rate of 10% per decade to reach a medium-term harvest level in decade 4 of 1 265 000 cubic metres per year. This level is maintained until the harvest level can rise to the long-term harvest level of 1 680 000 cubic metres per year in decade 14.

The factors that cause the large decline in harvest levels in the worst case scenario (i.e., age class gaps and natural regeneration) also act here. Furthermore, when the harvest levels over the next 20 years are lower only about 30% of the regenerated stands created during the mountain pine beetle outbreak are managed stands with high yields. This means that even less volume is available to harvest in the medium term and the age class gap that limits the availability of harvestable timber in decades 7 and 8 still determines the medium-term harvest level.

7 Summary and Conclusions of the Timber Supply Analysis

7.1 Base case

Several land use and forest management initiatives have been implemented since the last timber supply analysis was conducted for the Lakes TSA in 1995. The major changes include the implementation of the *Forest Practices Code*, the completion and approval of the *Lakes Land and Resource Management Plan (LRMP)*, the completion of local site productivity studies for pine, and the awarding of a *Community Forest Pilot Agreement*. As well, there have been some changes in the management assumptions, including the use of lower minimum harvestable ages.

Compared with the 1995 timber supply analysis, the *Forest Practices Code*, the *LRMP* and *Community Forest Pilot Agreement* acted to decrease the timber supply by removing area from the timber harvesting land base. The timber harvesting land base is approximately 11% smaller than in the 1995 analysis. The *Forest Practices Code* and *LRMP* also acted to decrease the timber supply by imposing additional management requirements for landscape-level biodiversity, stand-level biodiversity, riparian management areas and wildlife habitat. The results of the site productivity study for pine provided higher estimates of productivity and the lower minimum harvestable ages provided flexibility to harvest timber in periods when mature timber is in short supply. These latter two factors acted to increase the timber supply. Overall the increased productivity estimates and lower minimum harvestable ages outweighed the land removals and additional management requirements.

The current AAC attributable to the TSA is 1.462 million cubic metres per year, which is 38 000 cubic metres per year less than the 1995 AAC of 1.5 million cubic metres per year. This reduction accounts for the addition and expansion of several woodlot licences, whose AACs are set separately from that of the Lakes TSA.

The results of this timber supply analysis suggest that the current AAC in the Lakes TSA of 1.462 million cubic metres per year can be maintained for 11 decades before increasing to a long-term harvest level of 1.695 million cubic metres per year. The base case results reflect current knowledge and information on forest inventory, growth and management.

7.2 Sensitivity analysis

One alternative to the base case harvest forecast shows that it may be possible to increase the short-term harvest level immediately to the long-term harvest level without affecting future timber supply or growing stock stability. This maximum non-declining harvest alternative is more sensitive, and more clearly quantifies the response, to uncertainty in factors that affect timber supply, so it was used as the reference when conducting sensitivity analysis.

Uncertainty exists about several factors important in defining timber supply. A series of sensitivity analyses showed that these uncertainties affect timber supply to varying degrees. Table 10 summarizes the results for all sensitivity analysis that had an impact of more than 2% on the maximum non-declining harvest forecast of 1.695 million cubic metres per year. It compares cumulative timber supply for the short-, medium- and long-terms.

The uncertainties with the largest potential negative effects in the short term (next 20 years) are the size of the timber harvesting land base and timber volume estimates for existing stands. Increases in minimum harvestable ages could have a negative effect, but only if increased by more than 20 years.

Reducing the size of the timber harvesting land base has an impact that is less than the size of the reduction. This occurs because the reduction places more old forest outside of the timber harvesting land base, so less old forest needs to be retained inside the timber harvesting land base. This offsets the impact of reducing the size of the timber harvesting land base. Establishment of old-growth management areas has been identified as a source of unquantified reductions to the size of the timber harvesting land base. Uncertainty about the definition of problem forest types may result in a slight increase in the timber harvesting land base.

Reductions in volume estimates for existing unmanaged stands also have impacts that are less than the size of the reduction, because of the large area of old timber that is available for harvest. An inventory audit of the Lakes TSA indicates that the inventory is statistically acceptable, so there is no reason to expect that volume estimates for existing stands are overestimated.

None of these factors reduce the short-term harvest level below that of the current AAC attributable to the TSA. The uncertainties with the largest potential effects on projected harvests over the medium term (21-100 years) are the same as those for the short term. Uncertainty about whether pine stands will achieve the full site potential could have negative effects in the medium term.

The uncertainties with the largest potential negative effects in the long term (beyond 100 years) are the size of the timber harvesting land base, timber volume estimates for regenerated stands, and site productivity estimates. The effect of reductions in the size of the timber harvesting land base is the same as for the short term. Completion of landscape unit planning by July 2002 will verify land base reductions for old-growth management areas. No evidence suggests that volume estimates for managed stands are unreasonable. However, reductions in timber volume estimates for regenerated pine stands could occur if the predicted increases in site productivity are not realized. This may be partially offset by higher volume estimates for regenerated spruce and fir/balsam stands due to possible increases in site productivity estimates for these stands.

Within the ranges of uncertainty tested, several factors were shown to have little to no effect (2% or less) on the maximum non-declining harvest forecast. These factors include changes to minimum harvestable ages up to 20 years, capping volume estimates for old stands after 250 years of age, changes to maximum allowable disturbance for VQOs, green-up periods, changes in forest cover requirements to approximate adjacency constraints or the age at which stands achieve old-forest characteristics, and applying requirements for old-growth representation at the site series level.

A discrepancy was found in the disturbance limits for VQOs that were modelled for the base case, which produced a minor reduction (1.8%) in the long-term harvest level when corrected. Green-up ages may have been overestimated in the base case, which would have a positive effect on timber supply. The assumptions about how stands age outside of the timber harvesting land base had a potential impact of less than 4%, but did not affect the short-term harvest level.

Table 10. Summary of harvest forecasts for base case and sensitivity analyses with significant effects — Lakes TSA, 2001

Report section	Harvest forecast description	Per cent (%) relative to maximum non-declining flow harvest alternative		
		Short term (1-20 years)	Medium term (21-100 years)	Long term (> 100 years)
	Total volume harvested for the maximum non-declining harvest alternative	34 million m^3	136 million m^3	254 million m^3
4.1	1995 base case	88	85	81
	2001 base case	86	86	99
5.1	Alternative harvest flow — maximum non-declining flow	**100**	**100**	**100**
	Alternative harvest flow — maximize first decade	117	100	100
5.2	Timber harvesting land base increased by 10%	105	105	105
	Timber harvesting land base decreased by 10%	93	93	93
5.3	Pine site productivity — half of site index adjustment applied	100	92	86
5.4	Productivity of old stands — site index adjustment for spruce, fir and balsam	104	104	104
5.5	No perpetual aging outside timber harvesting land base — maximum age 300 years	100	98	97
	No perpetual aging outside timber harvesting land base — maximum age 250 years	100	97	96
5.6	Minimum harvestable ages — increased by 30 years	96	96	98
5.6	Existing (unmanaged) stand volumes increased by 10%	110	110	100
5.6	Existing (unmanaged) stand volumes decreased by 10%	94	94	100
5.6	Regenerated (managed) stand volumes increased by 10%	105	105	110
5.6	Regenerated (managed) stand volumes decreased by 10%	100	99	90

7.3 Critical issue analysis — mountain pine beetle outbreak

A mountain pine beetle outbreak has expanded beyond what was originally predicted for the base case. A critical issue analysis examined several scenarios and tested several key assumptions. Table 11 summarizes the results for all sensitivity analysis by comparing cumulative timber supply for the short-, medium- and long-terms.

A worst case scenario was developed based on current rates of spread of the mountain pine beetle. This scenario assumed that the maximum amount of timber that could be harvested and absorbed by markets was 3.0 million cubic metres per year for 10 years. The worst case scenario harvest forecast has a decline of 35% per decade with a medium-term harvest level of 1 270 000 cubic metres per year. The harvest forecast is affected by current gaps in the age class distribution that determine the medium-term harvest level, particularly in decades 7 and 8.

Uncertainty in the size of the outbreak was tested by developing a moderate case scenario, which assumed a reduced rate of spread in the second 5-year period, and a best case scenario, which assumed that the outbreak would be stopped by a cold winter in 2001-2002. These scenarios show reduced medium-term impacts, with the best case scenario having no impact relative to the maximum non-declining forecast.

Impact on several uncertainties were tested with sensitivity analysis, including how long killed timber would remain merchantable, regeneration assumptions, and the ability of markets to absorb the higher quantities of harvested timber. If attacked timber will last for 10 years, mid-term impacts are greatly reduced. If attacked stands regenerate with a 5-year regeneration delay instead of a 10-year regeneration delay, then there is only a slight increase in the medium-term harvest level of 1%. If harvest levels cannot increase to 3.0 million cubic metres per year, then the medium-term harvest level will drop further compared with the worst case scenario.

Table 11. Summary of harvest forecasts for base case and sensitivity analyses — Lakes TSA, 2001

Report section	Harvest forecast description	Per cent (%) relative to maximum non-declining flow harvest alternative		
		Short term (1-20 years)	Medium term (21-100 years)	Long term (> 100 years)
	Percentages are related to the total volume harvested in each term for the maximum non-declining harvest alternative	34 million m^3	136 million m^3	254 million m^3
5.1	Alternative harvest flow — maximum non-declining flow	**100**	**100**	**100**
6.2	Worst case scenario	146	77	96
6.4	Moderate case scenario	159	88	96
	Best case scenario	133	103	96
6.5	10 year merchantability for attacked timber	159	91	97
6.6	Regeneration delay — 5 years instead of 10	146	77	96
6.7	No additional salvage — 1.695 million initial harvest level	94	94	100
6.7	No additional salvage — 1.462 million initial harvest level	105	105	110

7 Summary and Conclusions of the Timber Supply Analysis

7.4 Summary

This analysis indicates that based on current inventory, growth and yield information, and the current management regime, timber harvests in the Lakes TSA could be maintained at the current level for at least 11 decades before rising to the long-term harvest level. The analysis also indicated that it may also be possible to increase the current harvest level immediately to the long-term level. The analysis indicates that several factors could affect timber supply. However, there is no evidence to suggest that short-term harvest levels are at risk.

The major source of uncertainty that could negatively affect the medium- or long-term harvest levels is site productivity estimates for pine stands. One minor source of uncertainty that could negatively affect the medium- and long-term harvest levels is how stands age outside of the timber harvesting land base. Sources of uncertainty that could increase the short-, medium- and long-term harvest levels are green-up periods, productivity estimates for spruce and fir/balsam stands, and an increase in the size of the timber harvesting land base resulting from new criteria for problem forest types.

A critical issue in this analysis is a major outbreak of mountain pine beetle. A worst case scenario, based on the current rate of spread, showed that the harvest level can be increased to 3.0 million cubic metres per year for 10 years, with little impact on the long-term harvest level, but with a medium-term harvest level of 1 270 000 cubic metres per year. Medium-term impacts could be reduced if attacked timber remains merchantable for 10 years instead of becoming an immediate unsalvaged loss. However, under the worst case scenario, if harvesting is not increased above the maximum non-declining level, then the medium-term harvest level could fall to 1 225 000 cubic metres per year.

8 Socio-Economic Analysis

The impact of timber supply adjustments on local communities and the provincial economy is an important consideration in the timber supply review. This socio-economic analysis compares the level of forestry activity currently supported by timber harvested from the Lakes TSA to the level of activity that could be supported as the timber supply moves towards its long-term harvest level.

The socio-economic analysis examines the short- to long-term harvest levels as projected in the base case harvest forecast. The base case is intended to reflect current forest management practices; consequently, the socio-economic analysis does not evaluate alternative management scenarios.

The socio-economic analysis includes:

- a profile of the current socio-economic setting;
- a description of the Lakes TSA forest industry; and
- an analysis of the socio-economic implications of the base case harvest forecast.

8.1 Current socio-economic setting

8.1.1 Overview

The socio-economic analysis focuses on the timber supply from the Lakes TSA, located on the western edge of British Columbia's central interior plateau close to the province's geographical centre. The Lakes timber supply area comprises approximately 1.12 million hectares.

8.1.2 Population and demographic trends

According to the 1996 Census, the population of the Lakes Forest District increased 18% since 1991 to 6,900. In comparison, the population of the province increased by 14% over the same period. During most of the 1980's, the Lakes Forest District experienced net migration outflows, but has had some positive net migration more recently. The projection is for negligible migration to the area, but the positive natural increase will ensure steady growth for the area. The population of the Lakes TSA is concentrated in the Village of Burns Lake (2523) which is located on Highway 16 between Houston and Vanderhoof. By 2005, the population of the district is expected to grow to approximately 7600.[2]

8.1.3 Economic profile

In 1999, the unemployment rate in the Lakes TSA was about 6.3%, slightly lower than the provincial average (7.2%). The Lakes TSA is not well diversified though, and is heavily dependent on the forest industry with about 43% of residents' income derived from forest-based employment[3]. The Babine Forest Products sawmill in Burns Lake is one of the largest in the province. Agriculture in the area consists mainly of cattle ranching. Mining was a significant employer in the area but since the closing of the Bell Mine in Granisle (in the adjoining Morice TSA) in 1992 it has been less important. There is mineral potential in the area that could be developed in the future.

(2) B.C. Stats. Population Section.

(3) The 1996 Forest District Tables, April 1999, Ministry of Finance and Corporate Relations.

8 Socio-Economic Analysis

Burns Lake is the location of two major timber processing facilities; the Babine Forest Products sawmill (one of the largest in the province), and the Babine Timber Ltd. post, pole and lumber facility.

During 1999 direct forestry-related employment at Lakes TSA mills amounted to close to 350 positions. Figure 28 illustrates the shares of total employment by industry sector for the Lakes Forest District.

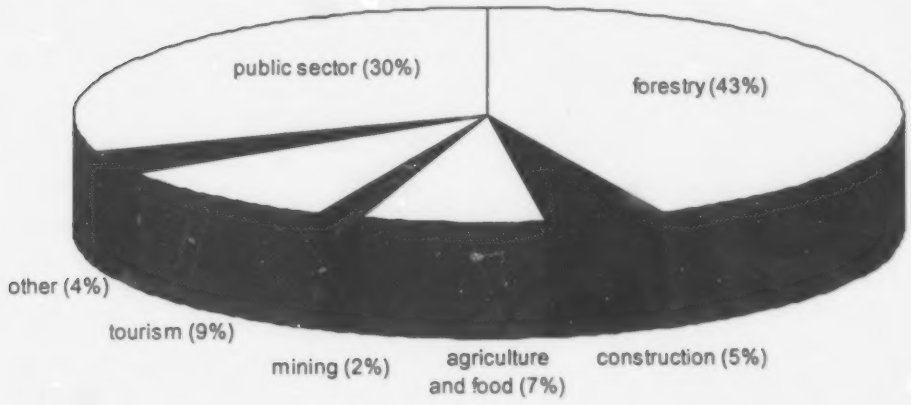

Figure 28. Total employment by basic sector, 1996.*

Notes: The figures are for the Lakes Forest District. Percentages reflect direct, indirect, and induced employment supported by the basic sector. "Other" (basic sectors) consist of some manufacturing, and transportation.

Source: The 1996 Forest District Tables, B.C. Ministry of Finance and Corporate Relations.

The forest sector supports numerous other jobs in the region through companies and employees purchasing goods and services from local businesses. This spending is another indicator of the role forestry has in the economy. Each 100 direct forestry jobs in the Lakes TSA are estimated to support a further 20 to 25 indirect and induced jobs*[4], depending on the type of forestry activity (logging or processing) and the associated level of income. In comparison, each 100 public sector jobs support 18 additional positions, while each 100 tourism jobs support approximately six positions.

Basic sector
Sectors of the economy, such as forestry, tourism and mining, that create flows of income into the region and are assumed to be drivers of the local economy. Non-basic sectors, such as retail outlets, are supported by basic sectors.

Indirect and induced jobs
Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

(4) Ibid.

8.2 Lakes TSA forest industry

8.2.1 Current allowable annual cut

In 1996, the current allowable annual cut (AAC) for the Lakes TSA was set by the chief forester at 1.5 million cubic metres. The AAC is apportioned into a number of licence types as outlined in Table 12. Four larger ventures have replaceable forest licences in the TSA accounting for roughly 70% of the total AAC (one million cubic metres). The remainder is apportioned among smaller forest licences and other forms of tenure including timber sale licences and the Small Business Forest Enterprise Program (SBFEP).

Table 12. Lakes TSA allowable annual cut apportionment, by licence type

Licence types	AAC (cubic metres)	Per cent (%)
Forest Licences — replaceable	1 008 850	67.3
Small Business Forest Enterprise Program (SBFEP)	413 078	
Timber Sale Licences	1 795	0.1
Woodlot Licences	52 600	3.5
Community Forest Pilot Agreements	23 677	
Total	1 500 000	100.0

Source: Ministry of Forests.

8.2.2 Lakes TSA harvest history

The actual annual harvest level is an important indicator of forestry activity in the timber supply area. While the AAC is the maximum allowable annual harvest level, the actual volume of timber harvested in a particular year indicates the economic activity supported by the timber supply area. If actual annual harvest levels are consistently less than the AAC, then economic activity is below its full potential. This gap between actual and allowable harvest activity will influence the potential short-term impacts of changes to the AAC.

From 1997 to 2000 approximately 1.6 million cubic metres of crown timber were harvested annually from the Lakes TSA (1.53 million cubic metres from the licence types listed above and 67 000 cubic metres under right-of-way and other special cutting permits). Additional (non-AAC) sources of timber include private lands and Indian reserves, which amounted to approximately 60 000 cubic metres per year over the same period. The Lakes TSA makes up about 20% of the total actual harvest in the Prince Rupert Forest Region (7.4 million cubic metres) while the region, in turn, accounts for about 10% of the total provincial harvest (73 million cubic metres).

8 Socio-Economic Analysis

Table 13 summarizes the volume of timber harvested in the Lakes TSA from 1997 to 2000. It indicates a fairly steady profile over the period, taking into account provisions for cut control[5] that allow licensees to vary their harvest levels based on operating and market conditions.

Table 13. Lakes TSA volumes billed, by licence type, 1997-2000

Tenure	Cubic metres				
	1997	1998	1999	2000	Average 1997-2000
Forest Licences	911 414	960 090	890 715	1 151 335	978 389
Small Business Forest Enterprise Program (SBFEP)	419 454	526 965	487 156	540 426	493 500
Other[a]	62 567	121 226	156 063	162 912	125 692
Total	1 393 435	1 608 281	1 533 934	1 854 673	1 597 581

Source: Ministry of Forests.

(a) Other consists of cutting permits such as right-of-way, road permits, woodlot licences and other smaller permits.

8.2.3 Lakes TSA major licensees

Babine Forest Products Co. Ltd.

Babine Forest Products Co. Ltd. (Babine) a subsidiary of Weldwood of Canada Ltd. and West Fraser Timber has a replaceable forest licences to harvest 409 942 cubic metres per year in the Lakes TSA. Table 14 outlines Babine's recent harvest activity in the TSA and its 1999 employment levels for TSA operations.

Babine operates a modern, efficient and highly technological sawmill at the east end of Burns Lake (21 km east of the town of Burns Lake). The operation produces in excess of 200 million board feet of dimension and Machine Stress Rated (MSR) lumber annually and is one of the most productive, highest recovery and lowest cost producers in the province. To meet increasingly sophisticated customer needs and respond to changing global market conditions, Babine is attempting to maximize the value of its timber resource by diversifying its product mix and manufacturing higher-valued products specifically for export markets. Most of the sales to North American customers are shipped by rail directly from the sawmills. The remainder are shipped by truck or by water through deep-sea terminals at Kitimat.

(5) A licensee's harvest may differ from the AAC by up to 50% on an annual basis, although the average harvest must be within 10% of the AAC over each five-year period.

8 Socio-Economic Analysis

The Babine sawmill can process close to 850 000 cubic metres of timber per year. Wood chips are trucked to the Canadian Forest Products Ltd. (Canfor) pulp and paper complex in Prince George where they support additional employment. In 1999, Babine's Lakes TSA processing supported approximately 300 direct jobs (including a pro-rata share of the employment in Prince George).

Table 14. Babine Forest Products harvest and direct employment statistics

Allowable annual cut	431 518 cubic metres
2000 harvest	462 322 cubic metres
1997-2000 average harvest	402 316 cubic metres
Direct employment (person-years)	
Harvesting, silviculture and administration	108
Processing	240

Note: The employment figures relate to the volumes harvested from the Lakes TSA land base only.

Babine Timber Ltd.

Babine Timber Ltd. (Babine Timber), a wholly-owned subsidiary of Babine Forest Products Co. Ltd. has a replaceable forest licence to harvest 130 605 cubic metres per year in the Lakes TSA. Table 15 outlines the company's recent harvest activity in the TSA and its 1999 employment levels for TSA operations.

Timber from the Babine Timber Ltd. forest licence supplies the Decker Lake speciality sawmill and pole treating facility (15 kilometres west from the town of Burns Lake) and the Burns Lake Speciality Wood Ltd. (BSW) remanufacturing operation in the community of Decker Lake. The Decker Lake sawmill focuses on producing treated utility poles and differentiated lumber for Canadian and export markets and can support about 80 manufacturing positions. BSW, which commenced operation in 1992, produces a mix of value-added products for both domestic and export markets and employs approximately 25 people. Wood chips from Decker Lake support additional employment in Prince George.

Table 15. Babine Timber harvest and direct employment statistics

Allowable annual cut	130 605 cubic metres
2000 harvest	71 491 cubic metres
1997-2000 average harvest	117 745 cubic metres
Direct employment (person-years)	
Harvesting, silviculture and administration	46
Processing	83

Note: The employment figures relate to the volumes harvested from the Lakes TSA land base only.

8 Socio-Economic Analysis

West Fraser Mills Ltd.

West Fraser Mills Ltd. (West Fraser) has a replaceable forest licence to harvest 367 194 cubic metres per year in the Lakes TSA mostly destined for its Fraser Lake sawmill in LeJac (in the neighbouring Prince George TSA). In addition, West Fraser holds 15 other licences throughout the province, totalling 4.2 million cubic metres per year of allowable annual cut, making it the fourth largest tenure holder in British Columbia. West Fraser does not have a processing facility within the Lakes TSA. Table 16 outlines West Fraser's recent harvest activity in the Lakes TSA and its 1999 employment levels for TSA operations.

Table 16 West Fraser Mills Ltd. harvest and direct employment statistics

Allowable annual cut	367 194 cubic metres
2000 harvest	498 875 cubic metres
1997-2000 average harvest	362 139 cubic metres
Direct employment (person-years)	
Harvesting, silviculture and administration	87
Processing	0

Note: The employment figures relate to the volumes harvested from the Lakes TSA land base only.

Rustad Bros. & Company Ltd.

Rustad Bros. & Company Ltd. (Rustad) manages a replaceable forest licence allowing the harvest of 53 627 cubic metres of timber per year in the Lakes TSA. Like West Fraser, Rustad has no local processing facility, but the company is closely allied with the Canfor pulp, paper and lumber mills in Prince George. Table 17 summarizes the harvest activity and employment associated with Rustad's operations in the TSA.

Table 17 Rustad Bros. & Co. Ltd. harvest and direct employment statistics

Allowable annual cut	53 627 cubic metres
2000 harvest	66 722 cubic metres
1997-2000 average harvest	55 022 cubic metres
Direct employment (person-years)	
Harvesting, silviculture and administration	11
Processing	0

Note: The employment figures relate to the volumes harvested from the Lakes TSA land base only.

8 Socio-Economic Analysis

L&M Lumber Ltd.

L&M Lumber Ltd. (L&M) has a replaceable forest licence to harvest 23 084 cubic metres per year in the Lakes TSA, along with a sawmill facility in the adjoining Vanderhoof Forest District. The sawmill commenced operations in April 1973 and underwent a major reconfiguration in the late 1980's. Since 1987, L&M has spent over $25 million on modifications to the mill to process smaller dimensional pine logs, which are characteristic of the area.

Table 18 summarizes the harvest activity and employment associated with L&M's operations in the Lakes TSA.

Table 18 L&M Lumber Ltd. harvest and direct employment statistics

Allowable annual cut	23 084 cubic metres
2000 harvest	51 925 cubic metres
1997-2000 average harvest	40 710 cubic metres
Direct employment (person-years)	
Harvesting, silviculture and administration	7
Processing	0

Note: The employment figures relate to the volumes harvested from the Lakes TSA land base only.

Other licensees

Other licensees in the Lakes TSA are mainly comprised of Small Business Forest Enterprise Program (SBFEP) participants with a total AAC apportionment of 436 651 cubic metres. From 1997 to 2000, SBFEP harvests averaged 493 500 cubic metres annually, which would normally support roughly 400 direct harvesting, silviculture and processing person-years.

8.2.4 Forest sector employment summary

In this section, the preceding harvesting and employment information is considered in the development of employment coefficients used to project future employment levels. For this purpose, the forest sector has been divided into the following three sub-sectors:

- harvesting and other woodlands-related employment such as log salvage and log scaling, and planning;
- silviculture activity including all planting and other basic and intensive operations; and
- primary timber processing employment.

Harvesting and silviculture employment

The harvesting sub-sector of the forest industry includes both company and contract loggers and is the most closely tied to the AAC; consequently, harvest level changes will affect this sub-sector first, and in close to the same proportions.The silviculture sub-sector is less linked to the current level of harvest, since silviculture activities occur at least three to six years after harvesting. Silviculture activity is divided into basic and enhanced work. Basic silviculture consists of surveys, site preparation, planting, brushing, cone collecting and some spacing. Enhanced, or intensive silviculture includes spacing, fertilizing, and pruning*. In the Lakes TSA, licensees are responsible for basic silviculture on areas harvested under forest licences. The provincial government is responsible for the remaining basic and all enhanced silviculture on Crown Land, which is normally completed by silvicultural contractors.

Primary timber processing employment

Processing facilities in the TSA rely on the Lakes TSA and other TSAs, tree farm licences (TFL)*, woodlots, and private lands in the area for their timber supply. Timber from the Lakes TSA also supports processors located throughout the region and province.

Forest Service employment

The Lakes TSA is administered by the Lakes Forest District office in Burns Lake. Currently, about 65 people work in the Forest District office. Since Forest Service activities are related more to the administration and enforcement of government policy than to the timber harvest, these jobs are not included in the analysis of forestry sector impacts.

Lakes TSA forestry employment and employment coefficient summary

Table 19 summarizes employment supported by the 1997-2000 average harvest in the Lakes TSA, and the corresponding employment coefficients. The employment and coefficients are separated into two groups:

1) TSA employment and employment coefficients, which comprise residents of the Lakes TSA who are employed within the Lakes TSA; and
2) Provincial employment and employment coefficients, which comprise all forest sector employment in the province that relies on the Lakes Timber supply; including both residents of the Lakes TSA and those who live elsewhere.

Calculations have been made for both groups to identify the importance of the forest sector within the Lakes TSA and to highlight the contribution that the Lakes TSA's forest sector makes to the provincial economy.

The average annual harvest from the timber supply area, from 1997-2000, was 1.598 million cubic metres, 6% higher than the AAC of 1.5 million cubic metres.

Pruning
The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.

Tree farm licence (TFL)
Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.

Table 19 Lakes TSA employment and employment coefficients

Activity	TSA person-years	TSA coefficients	Provincial person-years	Provincial coefficients
Harvesting and silviculture	465	0.29	518	0.32
Processing	322	0.20	723	0.45
Total direct	787	0.49	1,241	0.77
Indirect + induced	260	0.16	1,200	0.75
Total employment	1,047	0.65	2,441	1.52

Note: Employment estimates are person-years based on average 1997-2000 employment levels and the average 1997-2000 harvest of 1.598 million cubic metres. Person-years do not indicate individual jobs. Wood products transport, and road building and maintenance are included in indirect estimates. For further discussion please see the economic assessment methodology appendix.

More detailed information regarding employment coefficients is presented in Appendix B, "Socio-Economic Analysis Background Information."

8.2.5 Lakes TSA employment income

During the period 1997 to 1999 the average annual income for direct forest sector employees was approximately $48,100; and $30,700 for indirect and induced employment (in 1999 dollars). Based on these averages, current harvesting, silviculture, and processing of timber from the Lakes TSA generates an estimated $61.0 million in direct wages and salaries and $44.8 million in indirect and induced wages and salaries, annually throughout the province (see Table 20).

Table 20. Average annual direct and indirect/induced incomes and total employment income, -1999

	Average annual income (1999 dollar value)	Total annual income ($ millions)	Total income ($ per '000s m³)
Direct	48,100	61.0	38,200
Indirect / induced	30,700	44.8	28,000
Total income		105.8	66,200

Source: Statistics Canada, Survey of employment payrolls and hours.

8.2.6 Provincial government revenues

Provincial government revenues from the forestry industry include stumpage, royalties and rent payments, other taxes such as logging, corporate capital, sales, property and electricity taxes, and income taxes from direct, indirect and induced employees.

From 1997-2000, average stumpage and rent payments for Crown timber in the Lakes TSA were approximately $60.8 million per year. Forest and corporate taxes and revenues generated $11.9 million, while employment supported by the Lakes timber harvest accounted for $9.0 million in provincial income taxes (see Table 21).

Table 21. Average annual provincial government revenues, 1997- 2000

	Average annual revenue 1997-2000 ($1999 millions)	Revenue ($ per '000s m³)
Stumpage, rents and royalties	60.8	38,000
Industry taxes	11.9	7,500
Provincial income tax	9.0	5,600
Total government revenues	81.7	51,100

8.3 Socio-economic implications of the base case harvest forecast

The base case harvest forecast shows that a harvest level of 1.462 million cubic metres could be maintained for the next 11 decades, which would imply a very stable timber supply projection. However, due to the mountain pine beetle infestation the analysis also examines a uplift harvest level of 3.0 million cubic metres for 10 years. The socio-economic analysis on the base case harvest level and uplift considers:

- the short- and long-term implications of alternative harvest levels for both the Lakes TSA and the province;
- possible impacts on the communities within the TSA;
- timber requirements of processing facilities within the Lakes TSA; and
- regional timber supply implications.

The socio-economic analysis considers the average levels of forestry activity that the base case harvest forecast could support, assuming that employment changes by the same percentage as the harvest level, and that the proportion of harvesting, processing, and silviculture employment remains the same. Since the analysis also assumes that the types and proportions of products manufactured remain constant, it does not attempt to predict how timber flows, technology or product lines may change in response. The analysis provides an indication of the magnitude of impacts to expect within a constantly changing socio-economic environment.

Employment and income impacts are divided into direct, indirect and induced components; the sum of all the components is the total impact. Direct impacts reflect harvesting, silviculture, and processing activity. Indirect impacts are the result of direct businesses purchasing goods and services, and induced impacts are the result of direct and indirect employees spending their incomes on consumer goods and services.

Table 22 estimates the range of impacts the base case harvest forecast may have on employment and income. Ranges are utilized to reflect the availability of employment insurance and social assistance payments, and their mitigating effects in the shorter term. The lower end of the range reflects induced impacts which are diminished in the short term, because employment insurance and social assistance provide income support to displaced workers who might otherwise move to the region. The upper end of the range represents long-term impacts when new workers do enter the area, and local spending patterns are more fundamentally affected. In reality, a combination of these two scenarios — some workers accessing social assistance payments, some finding temporary employment in the region and some moving to the area permanently — is more likely to occur.

8.3.1 Short- and long-term implications of alternative harvest levels

Lakes TSA employment and income impacts

For accounting purposes, TSA employment and income includes only that of workers who are supported by the TSA harvest and who reside within the TSA. Workers who come to the TSA to work but who reside outside the TSA are included in the provincial impact section, as is employment supported by Lakes TSA timber processed at mills outside the TSA. Table 22 indicates the employment and income that could be supported within the Lakes TSA by the base case harvest forecast. If fully harvested and processed, the current AAC of 1.5 million cubic metres would support approximately 739 person-years of direct employment and another 244 indirect and induced person-years of employment within the timber supply area. Approximately $30.8 million (1999 dollar value) total local after-tax annual income would be supported by the Lakes timber supply. Approximately 65% of all direct employees reside within the Lakes TSA.

The base case harvest level of 1.462 million cubic metres would support approximately 960 person-years of employment; a decrease of about 25 person-years (2.5%) from levels supported by the current AAC. An uplift harvest level of 3.0 million cubic metres per year in the first decade could support approximately 1,478 person-years of direct employment and 489 person-years of indirect and induced employment; an increase of approximately 984 person-years from levels supported by the current AAC. Total after-tax employment income would double from current levels.Changes to the Lakes TSA harvest levels should be expected to have the greatest effect on residents of Burns Lake; the largest centre in the TSA. However, Lakes TSA processing is also dependent on the regional timber supply situation, just as processing in Prince George, Vanderhoof and LeJac is dependent on Lakes TSA timber.

Provincial employment and income impacts

Provincial employment and income impacts include all forest sector employment supported by the timber harvested from the Lakes TSA. Assuming the base case harvest level of 1.462 million cubic metres is fully harvested and processed, the Lakes TSA can support at least 1,136 person-years of direct forestry employment and a further 1,335 person-years of indirect and induced employment across the province. A harvest level of 3.0 million cubic metres per year would change total employment potential by about +2,500 person-years, about half of which would be direct forestry jobs. These person-years are only projections of full-time year-round employment and are based on multipliers. In the event that harvest levels increase in the Lakes TSA, it is likely that some existing workers may simply have more hours of work. The multipliers are not adjusted by local conditions due to the difficulty in determining appropriate adjustment factors.

Provincial government revenue impacts

Based on current tax and stumpage rates, the base case harvest level of 1.462 million cubic metres has the potential to provide approximately $74.8 million annually to the provincial government (1999 dollar value). If the timber supply is increased to 3.0 million cubic metres, given the economic multipliers, the revenue contribution would double.

8 Socio-Economic Analysis

Table 22. Socio-economic impacts of the Lakes TSA base case forecast

	Current AAC	Timber supply harvest forecast: Base case Years 1-10	Timber supply harvest forecast: Mountain pine beetle uplift Years 1-10
Timber supply ('000s m³)			
AAC	1500	1462	3000
Harvest level (average 1999-2000)	1598		
Cumulative change		(38)	1500
Lakes TSA			
Employment		(person-years)	
Direct	739	720	1,478
Indirect/induced	244	238	489
Total	983	959	1,967
Cumulative change in total person-years		(91) – (42)	783-1,056
Net employment income		($ 1999 million)	
Direct	25.1	24.4	50.1
Indirect/induced	5.8	5.6	11.5
Total	30.8	30.1	61.7
Cumulative change in total income		(2.4)-0.8	25.6-32.1
Province (includes Lakes TSA)			
Employment		(person-years)	
Direct	1,165	1,136	2,331
Indirect/induced	1,370	1,335	2,739
Total	2,535	2,471	5,070
Cumulative change in total person-years		(284)-156	1,919-2,822
Net employment income		($ 1999 million)	
Direct	41.2	40.2	82.4
Indirect/induced	32.4	31.6	64.8
Total	73.6	71.7	147.2
Cumulative change in total income		(7.1)-3.3	58.1-79.5
Provincial government revenues		($ 1999 million)	
Provincial income tax	8.5	8.3	17.0
Stumpage and rent	57.1	55.6	114.2
Other B.C. revenues	11.1	10.9	22.3
Total B.C. revenues	76.7	74.8	153.4
Cumulative change in total revenue		(2.5)-(1.4)	70.7-72.8

Notes: Provincial employment includes both Lakes TSA employment and employment supported outside the TSA by Lakes TSA harvested timber. Income figures in Table 22 are net of taxes while those of Table 20 are gross income.

The ranges for employment and income changes take into consideration employment insurance and other social assistance programs. The range's upper limit is based on the assumption that all those who are unemployed are instantly mobile. The lower limit is based on the assumption that employment insurance and other social assistance payments will reduce the induced impacts of a change in harvest level.

8.3.2 Community level impacts

The impacts of short- and long-term changes in timber supply occur within a growing region. The more diversified the region the less effect changes in any one sector will have on the regional economy.

Given that the Lakes TSA harvest supply provides 40% of the basic employment in the TSA, changes to the timber supply would be expected to have a fairly significant impact on the overall economic trends of the region. It is anticipated that in the short term, the potential increase to the AAC for the next 10 years could lead to a significant increase to the harvesting and other woods-related jobs in the TSA and rippling effect on processing activity both in the TSA and in the larger regional economy.

The Burns Lake area of the TSA is the most dependent on the forest sector. As a result, Burns Lake is likely to be most affected by changes to the AAC.

8.3.4 Nature, production capabilities, and timber requirements of processing facilities

The potential short-term increase of the Lakes TSA timber supply could have a significant effect on local as well as on regional processing activity. The outcome, however, is also dependent on other regional TSA timber supply considerations.

8.3.3 Regional timber supply implications

The Lakes TSA provides about 50% more timber annually than the total milling requirements (about one million cubic metres per year) of the processing facilities in the TSA. The balance is processed in the adjoining Prince George TSA, and to a lesser extent in Houston in the Morice TSA.

In the Prince Rupert Forest Region, the previous timber supply review led to a reduction in the coniferous AAC of 6.8 %, or about 600 000 cubic metres. In two to three decades, the annual timber supply from the Prince Rupert Forest Region may fall by another 5%, or 400 000 cubic metres, assuming the forests are managed according to the latest round of timber supply reviews. The Prince George Forest Region is stable or marginally increasing over the same period.

Mill level impacts occur both as a result of changes in the volume of timber harvested from the Lakes TSA, as well as from harvest changes that occur throughout the region. However, it is not possible to predict which mills and TSAs will be most affected, or if new "value-added" operations will enhance/mitigate regional timber supply changes.

8.4 Summary

The forestry sector is an important source of employment and income for the Lakes TSA. The current AAC for the Lakes TSA is 1.5 million cubic metres. If the AAC is fully harvested and processed, it can support approximately 1,165 person-years of direct employment across the province, and a further 1,370 indirect and induced jobs.

The base case harvest level is 1.462 million cubic metres annually which would support about 2,471 jobs across the province; about 2.5% less than the current AAC. The timber supply analysis for the Lakes TSA indicates that the timber supply could be increased to 3.0 million cubic metres for 10 years for mountain pine beetle control and salvage. Given the current economic multipliers developed for the Lakes TSA, this harvest level could increase total employment potential by about 2,599 person-years; about 50% of which would be direct forestry jobs.

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10 Glossary

Allowable annual cut (AAC)	The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.
Base case harvest forecast	The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information.
Basic sector	Sectors of the economy, such as forestry, tourism and mining, that create flows of income into the region and are assumed to be drivers of the local economy. Non-basic sectors, such as retail outlets, are supported by basic sectors.
Biodiversity (biological diversity)	The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Biogeoclimatic (BEC) variant	A subdivision of a biogeoclimatic zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Biogeoclimatic zones	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Clearcut harvesting	A harvesting method in which all trees are removed from an area of land in a single harvest. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding. Note that retention of some live trees and snags for purposes of biodiversity now occurs on most clearcuts.
Coniferous	Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.
Culmination age	The age at which a timber stand reaches its highest average growth rate, or mean annual increment (MAI). MAI is calculated as stand volume divided by stand age. Culmination age is the optimal biological rotation age to maximize long-term volume production from a growing site.
Culturally modified tree	A tree or a remnant of a tree with evidence of traditional aboriginal forest use.
Cutblock	A specific area, with defined boundaries, authorized for harvest.

10 Glossary

Cutblock adjacency

The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.

Deciduous

Deciduous trees commonly have broad-leaves and usually shed their leaves annually.

Drainage

The surface and sub-surface water derived within a clearly defined catchment area, usually bounded by ridges or other similar topographic features, encompassing part, most, or all of a watershed. The term is sometimes used to describe an operating area or location.

Employment coefficient

The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

Employment multiplier

An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

Environmentally sensitive areas

Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of avalanches.

Forest cover objectives

Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency and Green–up**).

Forest cover requirements

Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency and Green–up**).

10 Glossary

Forest inventory

An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Forest Practices Code

Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

Forest type

The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.

Free-growing

An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.

Green-up

The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.

Growing stock

The volume estimate for all standing timber at a particular time.

Harvest forecast

The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

Higher level plans

Higher level plans establish the broader, strategic context for operational plans, providing objectives that determine the mix of forest resources to be managed in a given area.

Indirect and induced jobs

Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

Inoperable areas

Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.

10 Glossary

Integrated resource management (IRM)	The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.
Land and Resource Management Plan (LRMP)	A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision making, and resource sustainability.
Landscape-level biodiversity	The *Landscape Unit Planning Guide* provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.
Landscape unit	A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.
Long-term harvest level	A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
Model	An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.
Natural disturbance type (NDT)	An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas subject to less frequent stand-initiating disturbances usually have more older forests.

10 Glossary

Non-merchantable forest types

Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.

Not satisfactorily restocked (NSR) areas

An area not covered by a sufficient number of well-spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.

Old seral

Old seral refers to forests with appropriate old forest characteristics. Ages vary depending on forest type and biogeoclimatic variant.

Operability

Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.

Partial retention VQO

Alterations may be visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see **Visual quality objective**).

Person-year(s)

One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.

Protected area

A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).

Pruning

The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.

Regeneration delay

The period of time between harvesting and the date at which an area is occupied by a specified minimum number of acceptable well-spaced trees.

Retention VQO

Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity (see **Visual quality objective**).

Riparian area

Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

10 Glossary

Riparian habitat	The stream bank and flood plain area adjacent to streams or water bodies.
Scenic area	Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.
Sensitivity analysis	A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.
Seral stages	Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.
Site index	A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.
Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Timber harvesting land base	Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7* of the *Forest Act*.
Table Interpolation Program for Stand Yields	A B.C. Forest Service computer program used to generate yield projections for managed stands using a model that simulates the growth of individual trees based on internal growth processes, crown competition, environmental factors and silvicultural practices.

10 Glossary

Tree farm licence (TFL)	Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
Ungulate	A hoofed herbivore, such as deer.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Variable Density Yield Prediction model	An empirical yield prediction system supported by the B.C. Forest Service, designed to predict average yields and provide forest inventory updates over large areas (i.e., Timber Supply Areas). It is intended for use in unmanaged natural stands of pure or mixed composition.
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Volume estimates (yield projections)	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Wildlife tree	A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.
Woodlot licence	An agreement entered into under the *Forest Act*. It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.

Appendix A

Description of Data Inputs and Assumptions for the Timber Supply Analysis

Introduction

The following tables and commentary outline the methods and inputs used to derive the timber harvesting land base and to construct the timber supply model for the Lakes TSA Timber Supply analysis. This information represents current forest management in the area.

Current management is defined as the set of land-use decisions and forest and stand management practices currently implemented and enforced. Future forest management objectives that may be intended, but are not currently implemented and enforced are not included in this appendix.

The purpose of the Timber Supply Review is to provide information on the effects of current management on both short- and long-term timber supply in each timber supply area in the province. Any changes in forest management objectives and practices, and any improvements to the data will be included in subsequent timber supply analyses.

More detail on the derivation of many of the land base exclusions and modelling approaches is available in the March 1999 *Lakes Timber Supply Area Timber Supply Review Data Package*. This appendix includes any changes to the assumptions contained in the data package that were made as a result of its public review or any developments in current management that occurred after the data package was published. Any changes are noted in the appropriate section of this appendix.

A.1 Inventory Information

Table A-1. Inventory information

Data	Source	Vintage	Update	Scale
Forest cover (1995 update, projected to 1998 — note: disturbance generally updated to the end of 1994 in the 1995 update)	Ministry of Forests (MoF) standard inventory file	1989 and 1990	1995	1:20,000
The following inventories are all Lakes Forest District non-standard inventory files				
Visual resource inventory — scenic areas, visual inventory, VQOs	MoF District	1993	1997	1:50,000
Caribou winter range and management zones	MoF District	1993		1:50,000
Caribou migration corridor	MoF District	1996		1:50,000
Ungulate high value winter range	MoF District	1975	1993	1:50,000
Recreation areas	MoF District	1996		1:150,000
Backcountry lakes	MoF District	1996		1:150,000
Biological ecosystem networks (BENs) (Landscape-level habitat connectivity)	MoF District	1996		1:150,000
Grizzly bear areas	MoF District	1996		1:150,000
Special geographic areas (Sutherland, Uncha, Entiako)	MoF District	1996		1:150,000
Landscape units	MoF District	1997		1:150,000
Biogeoclimatic ecosystem classification (BEC) zoning	MoF Research Branch	1997		1:250,000
Updated woodlot licence file	MoF District	1997		1:20.000

Data source and comments:

- Backcountry lakes (walk-in lakes) — Digital file derived from *Interim IRM Strategies and Harvesting Guidelines for the Lakes Forest District* — 1993.
- BEC zoning — Updated from most recent file available from Research section in Prince Rupert Forest Region (PRFR).
- Biological ecosystem networks (BENs) — Mapping and digitizing contract completed in 1994. Mapping used by the Ministry of Environment, Lands and Parks staff when reviewing development plans.

A.1 Inventory Information

- Caribou migration corridor (VH, H, M, L) — Data obtained from *Land Management Handbook 37 Caribou Habitat Use in the Chelaslie River Migration Corridor and Recommendations for Management* by Steventon, J. Douglas. 1996. Translated to digital form. VH, H, M, and L refer to very high, high, moderate and low value corridors, respectively.
- Caribou winter range and management zones — Data obtained and digitized from *Land Management Report, 83 Management Strategy and Options for the Tweedsmuir-Entiako Caribou Winter Range* by Cichowski, D.B., and A. Banner. 1993.
- Grizzly bear areas — Mapping derived from Klaytunkut and Sutherland local resource use plans (LRUPs) completed in 1992.
- Landscape units — Established and digitized for the Regional Landscape Unit Planning Strategy (approved by Forest District Manager and BCE designate – November, 1997).
- Recreation areas — Digital file derived from *Interim IRM Strategies and Harvesting Guidelines for the Lakes Forest District* – 1993 and refined during the *LRMP* process in 1996.
- Special geographic areas (Sutherland, Uncha, Entiako) — derived from *Interim IRM Strategies and Harvesting Guidelines for the Lakes Forest District* – 1993 and *LRMP* (proposed protected areas).
- Ungulate high value winter range — Data obtained from Habitat Mapping and digitizing contract done in 1993 by Silvicon Services Ltd.
- Updated woodlot license file — Most recent digital version of approved woodlot licenses in the district. Obtained from district mapping and design section in September, 1998.
- Visual resource inventory — District-wide coverage of visual resources. This inventory was established and digitized in the early 90s and has been upgraded several times since. The inventory is the basis for establishment of District scenic areas and appurtenant VQOs.

A.2 Zone and Analysis Unit Definitions

A.2.1 Management zones (grouping) and objectives

For the purpose of modelling current forest management, several resource emphasis groupings were defined for this analysis based on the forest management objectives shown in Table A-2.

Table A-2. Objectives to be tracked

Objectives	Inventory definition
Visual and scenic area objectives: VQOs — for retention and partial retention	Non-standard mapped layer
Caribou winter range objectives	Non-standard mapped layer
Caribou migration corridor objectives	Non-standard mapped layer
Ungulate high value winter range objectives	Non-standard mapped layer
Recreation objectives	Non-standard mapped layer
Backcountry (walk-in) lakes objectives	Non-standard mapped layer
Key grizzly bear habitat objectives	Non-standard mapped layer
Riparian management objectives	Based on biological ecosystem network information
Integrated resource management (IRM)	Areas not subject to other specified management objectives
Landscape-level biodiversity by landscape unit and BEC variant	Non-standard mapped layer
Agriculture and settlement area for removals from timber harvesting land base	Non-standard mapped layer
Chelaslie landscape unit (beetle salvage)	Non-standard mapped layer

Data source and comments:

Riparian management objectives — connectivity corridors, as represented by strong and weak links in the biological ecosystem network (BEN) inventory, generally overlap riparian areas and therefore provide a good basis for estimating riparian zone requirements.

Objectives for ungulate winter range apply only outside of areas with objectives for caribou winter range and the caribou migration corridor.

The objective represented in the IRM zone was cutblock adjacency. The IRM zone included all areas outside of those managed for visual quality objectives, caribou winter range objectives, caribou migration corridor objectives, high value ungulate winter range objectives, backcountry lake objectives and grizzly habitat objectives. The IRM zone included portions of the BENs that are not contained within other resource management zones.

The loss of forested land to agriculture was restricted to those portions of the agriculture/settlement zone outside of recreation areas, backcountry lakes, and caribou, grizzly, and most moose habitat areas. See Section A.4.5, "Harvest scheduling priorities" for more detail.

See Section A.1, "Inventory Information," for the sources of mapping and zones referenced above.

A.2 Zone and Analysis Unit Definitions

A.2.2 Analysis unit characteristics

An analysis unit represents a combination of stands that grow or are treated similarly. Each analysis unit is composed of groups of forest stands that have similar tree species composition (as indicated by the inventory type group), and similar timber growing capability (as indicated by the site index in the forest inventory file). Each analysis unit is assigned its own timber volume projections (yield tables) for existing and future stands. Table A-3. defines the analysis units used for existing stands.

Yield tables for existing natural stands were derived using the variable density yield prediction (VDYP) growth and yield model. Yield tables for recent plantations and future stands were derived using the table interpolation program for stand yields (TIPSY). The following species symbols are used: F (Douglas-fir); B (balsam); S (spruce); Pl (lodgepole pine).

Table A-3. Definition of analysis units

	Criteria			
Analysis unit	**Species**	**Inventory type groups**	**Site index range (m @ 50 years)**	**Age (years)**
1	F, B	1, 4, 5, 8, 18-20	All	0 – 140
401	F, B	1, 4, 5, 8, 18-20	All	141 +
2	S	21-26	> = 18	All
3	S	21-26	12 – 17.9	0 – 140
403	S	21-26	12 – 17.9	141 +
4	S	21-26	< = 11.9	0 – 250
404	S	21-26	< = 11.9	251 +
5	Pl	28	> = 18	All
6	Pl	28	12 – 17.9	All
7	Pl	28	< = 11.9	All
8	Pl with F/S	29-31	> = 18	All
9	Pl with F/S	29-31	12 – 17.9	All
10	Pl with F/S	29-31	< = 11.9	All

Data source and comments:

Balsam and fir stands were grouped because of the small area occupied by these species in the Lakes TSA.

Analysis units 401-404 consist of older age classes in spruce, balsam and fir stands, which have an average site index lower than that for younger age classes. It is recognized that site index derived using existing inventory information from these sites may underestimate their actual productivity, but there are currently no site index adjustments available for these species in the Lakes TSA. Site index ranges are based on a breakdown of the existing range of site indices.

A.3 Definition of the Timber Harvesting Land Base

A.3.1 Land not administered by the British Columbia Forest

Ownership codes are generally used to identify whether the land can be considered to contribute to timber supply. Ownership codes 62C and 69C indicate Crown land in a forest management unit and miscellaneous reserves respectively. All areas with other ownership codes were removed from the land base considered available for timber supply. This includes areas under woodlot licence as their AACs are determined independently of the timber supply review process. This analysis accounted for all woodlot licenses issued prior to May 1998. An additional GIS coverage was used to identify woodlot licence areas not yet appearing in the forest cover inventory.

After the data package was published, the base case was revised to account for the removal of the *Lakes LRMP* proposed protected areas and the *Community Forest Pilot Agreement.*

A.3.2 Land classified as non-forest

Areas with projected type identity 6 are non-forested, and areas with projected type identity 8 have no typing available. These categories include alpine areas, rock and ice, lakes, swamps and rivers, which do not contribute to timber supply, and were excluded from the area considered available for timber harvesting.

A.3.3 Non-commercial cover

Areas with projected type identity 5 are occupied by non-commercial brush species. These areas are considered to be unlikely sites for timber production and were excluded from the area considered available for timber harvesting.

A.3.4 Environmentally sensitive areas

Some forest land is environmentally sensitive and/or significantly valuable for other resources. These areas are identified and delineated during a forest inventory and are called environmentally sensitive areas (ESAs). The ESA system uses the following classification: soil (Es), forest regeneration problems (Ep), snow avalanche (Ea), recreation (Er), wildlife (Ew), water (Eh) and fisheries (fisheries symbols). With the exception of avalanche and fisheries, two ESA categories are recognized: high and moderately sensitive.

In the context of timber supply analysis, ESAs may result in a reduction in the harvesting opportunity on these sites. Two strategies for accounting for management of ESAs are: per cent area reductions, and specific evaluation of individual ESA polygons for harvesting opportunity.

As noted previously only those areas where harvesting is expected to take place contribute to the timber harvesting land base. Thus it is important to separate the areas in which some limited harvesting will take place from those areas which are completely unavailable. Table A-4. identifies how much area was unavailable for harvesting due to ESAs.

A.3 Definition of the Timber Harvesting Land Base

Table A-4. Description of environmentally sensitive areas

Location	ESA category	ESA description	Reduction per cent (%)
Babine PSYU[a] # 134	R 1 & 2	High value localized recreation areas	90
	S 1	Highly sensitive soils	90
	S 2	Moderately sensitive soils	70
	P 1 & 2	Regeneration difficulty	60
Burns Lake PSYU # 154 and Ootsa PSYU # 155	R 1 & 2	High value localized recreation areas	90
	S 1	Highly sensitive soils	70
	S 2	Moderately sensitive soils	60
	P 1 & 2	Regeneration difficulty	60

(a) PSYU = public sustained yield unit. Used here to denote general location within the TSA.

Data source and comments:

A geographic information system (GIS) query of harvesting activities within ESAs was undertaken for harvesting occurring after 1990. This query revealed no harvesting activity within these areas. More detailed checks of harvested blocks revealed that some harvesting has occurred in ESA polygons. This difference appears to be due to the district disturbance updating process in which all existing ESA linework may not be maintained as disturbances are updated. The reduction percentages presented in Table A-4. represent current practice, based on input from experienced forest district staff.

Since the last timber supply review, reduction percentages for sensitive soil and recreation areas have been refined as requested in the chief forester's 1996 AAC Rationale. The resulting reductions are lower than those used in the previous TSR. For high-value localized recreation areas, a 90% reduction is used because some harvesting may occur in these areas. Reductions for sensitive soils have been adjusted to account for the different sensitivity of S1 and S2 areas and for sensitivity differences between PSYUs. In general, the Babine PSYU contains a higher proportion of salmon-bearing streams and areas of fine-textured erodable soils (Twain Creek, Pierre Creek, Sutherland River valley) than other areas within the TSA. Areas with sensitive soils in the Babine PSYU are therefore assigned a slightly higher reduction per cent than are such areas in other PSYUs.

The original data package also contained criteria for the Entiako caribou, but this area now lies within the Entiako protected area established under the *Lakes LRMP*.

A.3.5 Areas considered inoperable

Operability codes are generally based on the presence or absence of physical barriers or limitations to harvesting, logging methods (e.g., cable) and the merchantability of stands. Given the relatively easy terrain in the Lakes TSA, no areas are classified as inoperable due to terrain. Table A-5. lists areas that are inoperable due to soils and access limitations.

Table A-5. Description of inoperable areas

Inventory description	Code	Reduction per cent (%)
Some side drainages flowing into the Sutherland Valley	Planning cell # B011, B012, B013	70

Data source and comments:

Planning cells # B011, B012 and B013 were identified as being high soil hazard by interpretive slope stability and erosion hazard mapping done by regional soil specialists for this planning project. It is considered appropriate to treat these areas similar to ESA soil sensitive areas with a corresponding reduction factor of 70%. This affects only those side drainages that lie outside of the Sutherland protected area established under the *Lakes LRMP.*

The original data package also contained criteria for the low value caribou management zone, which was inaccessible, but this area lies within the Entiako protected area established under the *Lakes LRMP.*

The Small Business Forest Enterprise Program (SBFEP) in the district is concerned that there are small pockets of forested land that may not be accessible (potentially inoperable) for a number of reasons. Such areas are currently being identified and will be assessed in the next timber supply review.

A.3.6 Sites with low timber growing potential

Sites may have low productivity either because of inherent site factors (nutrient availability, exposure, excessive moisture, etc.), or because they are not fully occupied by commercial tree species. Typically, these stands are intermixed with other stands within the forested land base. As these stands are not considered to be harvestable, they need to be identified and removed from consideration for the timber harvesting land base.

Table A-6. Description of sites with low timber growing potential

	Characteristics				
Forest type	Inventory type group	Age (years)	Volume (m^3/hectares)	Site index (m @ 50years)	Reduction per cent (%)
Fir	1-8	200	< 140	< 11.0	100
Balsam	18-20	200	< 140	< 7.4	100
Spruce	21-26	200	< 140	< 5.4	100
Pine	28-31	160	< 140	< 7.6	100

Data source and comments:

Criteria defining low site stands evolved out of the 1995 timber supply analysis process. At that time the harvest level was based partly on the condition that major licensees would utilize stands of lower volume. The minimum acceptable volume was defined as 140 cubic metres per hectare. Stands with volumes less than this are not considered harvestable. The minimum volume must be achieved by the age specified in Table A-6 for a stand to be considered productive enough to be managed for timber supply. Together, these two criteria (volume and age) were used to define the minimum site index, used to identify which existing stands are unlikely to meet the minimum volume and age criteria.

A.3 Definition of the Timber Harvesting Land Base

A.3.7 Problem forest types

Problem forest types are stands that are physically operable and exceed low site criteria yet are not currently utilized or have marginal merchantability. In the Lakes TSA these types are excluded from the timber harvesting land base.

Table A-7. Problem forest types criteria

Description	Characteristics						
	Inventory type group	Species composition	Age (years)	Height (metres)	Volume (m^3/hectare)	Site index (m @ 50 years)	Reduction per cent (%)
Deciduous	35-42	—	All	All	All	All	100
Pure balsam types	18-19	—	251 +	All	All	All	100
Mixed balsam types	20	< 30% spruce or pine	251 +	All	All	All	100
Low height pine	28-30	—	141 +	< 17.5	< 140	< 10.1	100
Low height — other species	1-8 18-20 21-26	Fir Balsam Spruce	201 +	< 19.5	All	< 9.8 < 8.3 < 5.9	100

Data source and comments:

The threshold height for exclusion of pine from the timber harvesting land base has been reduced since the last timber supply review (TSR) based on a review of harvesting and utilization. The review showed that mature lodgepole pine stands with heights less than 19.5 metres were being harvested, and the lower height threshold was reduced to 17.5 metres for this TSR.

The minimum height and age criteria were converted to minimum site index criteria, which were used to identify which existing stands will not likely ever meet the minimum height and age criteria.

Deciduous stands — while harvesting of deciduous stands has been proposed in some woodlot licences, the volumes are small, and actual performance and economic feasibility have not been evaluated.

A.3 Definition of the Timber Harvesting Land Base

A.3.8 Roads, trails and landings

Separate estimates are made to reflect the loss of productive forest land to existing and future roads, trails and landings (RTL). Existing RTL estimates are applied as reductions to the current productive forest considered available for harvesting, and future RTL reductions are applied after stands are harvested for the first time in the timber supply model.

Table A-8. Estimates for existing and future roads, trails, and landings

Location	Age class (years)	Reduction per cent (%)
Existing RTLs	< 40	5.24
Future RTLs	> = 40	5.24

Data source and comments:

The results of a 1994 district survey to determine area lost to roads, trails and landings for the previous timber supply review are still valid. An assessment of 133 SBFEP final harvesting reports from between 1996 and 1998 confirms the 1994 survey results for areas lost within blocks. Data sources for the 1994 study included ground-based surveys, information from silvicultural prescriptions, advice from district engineering staff, and regional estimates by Prince Rupert Forest Region staff. Additional sources of data for the SBFEP study include:

- Information from Integrated Silviculture Information System (ISIS) records.
- Road lengths determined using the computer program INVSPECTS for PCs. When used in conjunction with road width estimates, road area can be calculated.

A recent forest district study showed an increase in the proportion of roadside *versus* conventional blocks. Roadside blocks now comprise about 80% of the area harvested, compared to 70% five years ago. This shift is reflected in the roads, trails and landings percentages.

The two-part 1994 survey determined the percentage of contributing land base in roads and landings outside harvested blocks and the percentage of roads and landings lost from contributing land within harvested blocks. The recommended 5.24% reduction for roads, trails and landings was calculated as follows:

Part 1	0.5% of contributing area in roads and landings outside blocks;	
Part 2	Roadside	4.2% of cutblock taken up by roads, trail and landings;
	Conventional	6.9% of cutblock taken up by roads, trail and landings;
	Pro-rated roadside/conventional based on the revised 80/20 split = 4.74%;	
	Per cent area reduction = 0.5% + 4.74% = 5.24%.	

A.3.9 Cultural heritage resources

According to the Wet'suwet'en landscape pilot project (undertaken by the forest district in cooperation with the First Nation), cultural heritage resources are generally accounted for through riparian, wildlife tree patch, problem forest type, or other removals from the timber harvesting land base. Recent documentation of significant areas of culturally modified trees may change this assumption as the extent of this information and its impact on harvesting activities are better understood. This new information will be used to augment traditional use surveys and will be factored into future timber supply reviews.

A.3 Definition of the Timber Harvesting Land Base

A.3.10 Riparian areas

Since there is no stream inventory available for the Lakes TSA, the findings of the *1996 Forest Practices Code Timber Supply Analysis* will be applied. This means that 5% of the timber harvesting land base will be excluded for riparian reserve zones, and 2% for riparian management zones. The total reduction of 7% should be applied as follows:

65% (of 7%) applied to analysis units (AUs) 1 to 4, 8 and 9 within biodiversity ecosystem network strong links;

25% (of 7%) applied to AU 1 to 4, 8 and 9 within biological ecosystem network weak links;

10% (of 7%) applied to AU 1 to 4, 8 and 9 over the remainder of the timber harvesting land base.

Data source and comments:

The analysis unit numbers above (1 to 4, 8 and 9) refer to any units with labels ending in those numbers. That is, the reduction percentages will be applied to any areas currently in analysis units (AU) 101-104, 108, 109, 208, 209, 308, 309, 401, 403 and 404 as well.

Riparian management zones will be treated as an area reduction rather than a yield table reduction. Reductions are focused in the strong and weak links of the biological ecosystem network (BEN) because that is where the riparian and wetland areas are located.

The *1996 Forest Practices Code Timber Supply Analysis* (page 29) contains details on how the reserve and management zone area estimates were derived.

A.3.11 Exclusion of specific, geographically defined areas

All parks and reserves designated by Order-in-Council have been excluded from the timber harvesting land base. These include: Tweedsmuir, Wistaria, Ethel F. Wilson, Pendleton Bay, and Dead Mans Island Provincial Parks. The *Lakes Land and Resource Management Plan* proposes additional areas for protection. The *Lakes LRMP* was approved by government after the data package was published. The proposed protected areas have therefore been removed from the timber harvesting land base for the base case.

A.4 Current Forest Management Assumptions

A.4.1 Current AAC attributable to the TSA

The current AAC for the Lakes TSA is 1 500 000 cubic metres per year. Since the last AAC determination, 38 000 cubic metres per year has been allocated to new or expanded woodlot licences (total AAC is 52 600 cubic metres). Therefore, the current harvest level (which excludes allocated woodlot licences) for this analysis is considered to be 1 462 000 cubic metres per year.

A.4.2 Utilization levels

The utilization levels define the maximum stump height, minimum top diameter inside bark (dib) and minimum diameter at breast height (dbh) by species, and are used in the analysis to calculate merchantable volume.

Table A-9. Utilization levels

	Utilization levels		
Species	**Minimum dbh (cm)**	**Maximum stump height (cm)**	**Minimum top dib (cm)**
Pine	12.5	30	10
Spruce	15	30	10
All others (BL & F)	17.5	30	10

A.4.3 Volume exclusions for mixed species stands

All deciduous species were excluded from the estimation of volume in coniferous-leading mixed species stands. All stands dominated by deciduous species were excluded from the timber harvesting land base (see Section A.3.7, "Problem forest types").

Some woodlot licensees in the district have shown interest in utilizing aspen. To date, only 200 cubic metres per year of annual harvest has been awarded to woodlot licensees on a trial basis for aspen utilization. This volume comprises a very small portion of the TSA harvest, and will not be considered in this TSR. If the deciduous species component of harvests expands, it will be assessed in future TSRs.

A.4.4 Minimum harvestable ages

The minimum harvestable age is the time required for a stand to grow to a harvestable size. Minimum harvestable ages are minimum criteria. While harvesting may occur in stands at the minimum ages to meet forest level objectives (e.g., maintaining overall harvest levels for a short period of time, or avoiding large changes in harvest levels), most stands will not be harvested until past the minimum ages because management for other resource values take precedence (e.g., requirements for the retention of older forest).

A.4 Current Forest Management Assumptions

Table A-10a. Minimum harvestable ages

Analysis unit		Minimum criteria		
		Minimum height (metres)	Minimum volume (m^3/hectares)	Minimum harvest age (years)
1	Balsam/fir	19.5	140	120
401	Old balsam/fir	19.5	140	155
2	Spruce, good	19.5	140	74
3	Spruce, medium	19.5	140	86
403	Old spruce, medium	19.5	140	94
4	Spruce, poor	19.5	140	128
404	Old spruce, poor	19.5	140	161
5	Pure pine, good	17.5	140	53
6	Pure pine, medium	17.5	140	75
7	Pure pine, poor	17.5	140	118
8	Pine mixed, good	17.5	140	55
9	Pine mixed, medium	17.5	140	74
10	Pine mixed poor	17.5	140	118
101	Regenerated balsam/fir	19.5	140	103
102	Spruce regenerated to pine, good	17.5	140	50
103	Spruce regenerated to pine, medium	17.5	140	70
104	Spruce regenerated to pine, poor	17.5	140	113
105	Regenerated pure pine, good	17.5	140	51
106	Regenerated pure pine, medium	17.5	140	74
107	Regenerated pure pine, poor	17.5	140	113
108	Regenerated pine mixed, good	17.5	140	52
109	Regenerated pine mixed, medium	17.5	140	75
110	Regenerated pine mixed poor	17.5	140	108

Table A-10b. Minimum harvestable ages for regenerated pine stands with a site index adjustment

	Regenerated pine analysis unit (with site index adjustment)		Minimum criteria		
			Minimum height (metres)	Minimum volume (m^3/hectare)	Minimum harvest age (years)
205	Pure pine, good	— SBS mc2	17.5	140	48
206	Pure pine, medium	— SBS mc2	17.5	140	48
207	Pure pine, poor	— SBS mc2	17.5	140	48
208	Mixed pine, good	— SBS mc2	17.5	140	49
209	Mixed pine, medium	— SBS mc2	17.5	140	49
210	Mixed pine, poor	— SBS mc2	17.5	140	49
305	Pure pine, good	— SBS dk	17.5	140	43
306	Pure pine, medium	— SBS dk	17.5	140	48
307	Pure pine, good	— SBS dk	17.5	140	53
308	Mixed pine, good	— SBS dk	17.5	140	47
309	Mixed pine, medium	— SBS dk	17.5	140	49
310	Mixed pine, poor	— SBS dk	17.5	140	54

Data source and comments:

The criteria used to generate minimum harvestable ages represent the current understanding of minimum merchantability and are consistent with land base reductions for low productivity. The minimum harvestable age is the age at which both the minimum height and minimum volume criteria are met. For existing natural stands, the ages were derived using the Variable Density Yield Prediction (VDYP) model. For managed, regenerated stands, the Table Interpolation Model for Stand Yields (TIPSY) model was employed. Site index adjustments for pine are discussed in Section A.4.8, "Regeneration assumptions in managed stands."

The data package presented analysis units 202-204 and 302-304, which represented spruce stands that were converted to pine and had a site index adjustment. However, it was not appropriate to adjust the site index for spruce stands, even though they are converted to pine, so these analysis units do not appear in Table A-10b.

Some analysis units were combined because their timber yield tables were very similar. See Section A.4.8, "Regeneration assumptions in managed stands" for details.

A.4 Current Forest Management Assumptions

A.4.5 Harvest scheduling priorities

Table A-11. Priorities for scheduling harvests

Description	Management zone or location	Analysis units	Period (10-year increments starting from present)	Priority 1 (high) — 100 (low) or minimum harvest level
Beetle salvage, beetle proofing and caribou management	Chelaslie landscape unit	5 to 10	1-2	1
Land base conversion	Agriculture/settlement zone	All	1-4	1 with maximum harvest of 50 hectares/year

Data source and comments:

The Chelaslie landscape unit is under high risk from Mountain Pine Beetle (MPB). MPB is currently moving into this area from the south (Entiako) and south-west (Tweedsmuir Park). Harvest priorities are to reduce risk and salvage existing infestations. The intent is to focus harvest on susceptible pine stands that are impassable to caribou during the first pass (ITG 28 and 30, age class 6, 7, 8 [101-250 years]).

Crown forested land within the agriculture/settlement zone is being harvested and converted to agriculture at an estimated rate of 50 hectares per year, which is expected to continue for four decades. The total conversion is estimated at 2000 hectares. The specific parcels of land that will be converted are unknown, but are likely to be areas that do not have objectives for wildlife or other resource emphases. The area to be converted was modelled using all of the agriculture/settlement zone outside of recreation areas, backcountry lakes and habitat areas (1494 hectares), which falls short of the estimated 2000 hectares. It is unlikely that area with deer habitat objectives will be converted, but area with moose habitat objectives may be converted. Therefore, the area modelled for conversion also included that portion of the agriculture/settlement zone in the draft Intata landscape unit having ungulate winter habitat objectives for moose (531 hectares). This area totals 2025 hectares, which is very close to the estimated conversion area. The timber supply model had a maximum harvest target of 50 hectares per year for this area, which was removed from the timber harvesting land base following harvest and did not contribute to forest cover requirements thereafter.

Aside from the priorities shown in Table A-11, stands were modelled for harvest using the relative-oldest first rule.

A.4.6 Silvicultural systems

Modified clearcut is the predominant silvicultural system in use in the Lakes TSA. Under this system a range of opening sizes (one hectare to several thousands of hectares) of even-aged forest is being produced. Cutting of adjacent blocks is restricted until green-up conditions are met. A characteristic of this system is the maintenance of older forest remnants within harvest blocks. These remnants are intended to function as wildlife tree patches, riparian reserves and management zones, and island remnants to conserve old-growth characteristics.

Partial cutting and selection systems are used but currently account for only 1% of the annual harvest. Horse logging under the SBFEP accounts for the largest proportion of these systems, approximately 10 000 cubic metres annually. Helicopter, high-lead and small log harvester/forwarding systems (Valmet) have also received some experimentation; however, because of the small volume involved, these systems will not be modelled.

A.4 Current Forest Management Assumptions

A.4.7 Unsalvaged losses

Table A-12. shows the estimated average annual unsalvaged volume loss to catastrophic events such as insect epidemics, fires, wind damage or other agents on the timber harvesting land base. The unsalvaged loss column reflects only those areas in which the volume will not be recovered or salvaged.

Table A-12. Unsalvaged losses

Location	Analysis units	Cause of loss	Unsalvaged losses (m^3)
All	All	Fire	2 819
All	All	Insects (MPB)	10 800
All	All	Blowdown	18 357
Total			**31 976**

Data source and comments:

Mountain pine beetle (MPB) is the major insect in the Lakes Forest District. No significant losses in excess of those taken into account in yield curves from other pests are believed to occur in this district, according to scaling and field staff. Nearly all identified trees are salvaged under current salvage practices. The only losses to insects are in areas treated using a fall and burn system. The loss estimate was reduced to account for the protected areas recommended by the *LRMP*. The original data package had a slightly higher unsalvaged loss for mountain pine beetle because it did not account for these protected areas. The loss is also 10 000 cubic metres higher than in the data package to account for the current expansion of the mountain pine beetle outbreak. These higher losses are expected to continue into the foreseeable future.

Fire losses are average volume burned over the last 10 years. Values from the previous TSR constitute the best available information: 9746 m^3 total loss – 6927 m^3 salvaged volume = 2819 m^3 unsalvaged loss.

Blowdown losses were calculated for harvest block perimeters, road rights-of-way and catastrophic blowdown. Salvaged losses were subtracted from the total lost to give the unsalvaged loss.

A.4.8 Regeneration assumptions in managed stands

Recent plantations and future stands are grown on managed stand yield tables (MSYTs) produced using the B.C. Forest Service table interpolation program for stand yields (TIPSY) growth and yield model. A MSYT may be built from a number of tables if more than one regeneration method is used within an analysis unit. When this is the case, tables are produced for the different regeneration methods (each method and species combination) and then aggregated into one table.

The silviculture program reflects the mix of treatments expected to be carried out according to the Lakes TSA Plan. This level of activity assumes basic silviculture on all sites plus incremental silviculture on some sites. Table A-13a. shows the regeneration assumptions by analysis unit for future stands, existing operable not satisfactorily restocked (NSR) areas, and young plantations that have been managed for density.

A.4 Current Forest Management Assumptions

Table A-13a. Regeneration assumptions by analysis unit

Existing analysis unit	Regenerated analysis unit	Species	Regen delay[a] (years)	OAFs[b] (%)		Regeneration method		Regenerated		
				1	2	Type	%	Species	%	Density
1, 101	101	Fdi, Bl	1	15	5	Plant	100	Bl Fd	50 50	2800
401	101	Fdi, Bl	0	15	5	Plant	100	Bl Fd	50 50	2800
2, 102	102	S	0	15	5	Plant	100	S Pl	60 40	2800
3, 103, 403	103	S	0	15	5	Plant	100	S Pl	60 40	2800
4, 104, 404	104	S	0	15	5	Plant	100	S Pl	60 40	2800
5, 105	105/205/305	Pl	0	20	5	Plant	100	Pl	10 0	2800
6, 106	106/206/306	Pl	0	20	5	Plant	100	Pl	10 0	2800
7, 107	107/207/307	Pl	0	20	5	Plant	100	Pl	10 0	2800
8, 108	108/208/308	Pl, S	0	20	5	Plant	100	Pl S	80 20	2800
9, 109	109/209/309	Pl, S	0	20	5	Plant	100	Pl S	80 20	2800
10, 110	110/210/310	Pl, S	0	20	5	Plant	100	Pl S	80 20	2800

(a) Regeneration delay is defined as the time after harvest but before seed germination occurs of the planted trees. Regeneration delays were applied in the FSSIM timber supply model, not in the TIPSY yield model.

(b) Operational adjustment factors (OAFs) are used to adjust timber yield estimates to account for operational factors. OAF1 is a constant percentage reduction to account for small unproductive areas within stands, uneven stem distribution and endemic losses that do not increase with age. OAF2 accounts for losses that increase with stand age, for example decay due to disease. In this case OAF2 increases from 0 at stand establishment and passes through 5% at 100 years of age.

A.4 Current Forest Management Assumptions

Data source and comments:

The species column in Table A-13a. refers to the leading species of the existing natural stand. Spruce-leading stands are currently being converted to pine-leading stands (i.e., 60% pine, 40% spruce), which was reflected in the regeneration assumptions contained in the original data package. According to the *Lakes LRMP*, management should maintain species diversity in accordance with the *Biodiversity Guidebook*. This approach would prohibit the conversion of spruce analysis units to pine analysis units. Since the *LRMP* has been approved, the regeneration assumptions for analysis units 2-4 and 102-104 now show regeneration to spruce leading stands (i.e., 60% spruce, 40% pine).

Regeneration delay — current practice, in most situations, is to plant one-year-old stock one season after harvest. The zero regeneration delay indicated is a rounded average (district staff estimate the actual average to be 0.25 year).

Provincial average operational adjustment factors (OAFs) values are applied to the managed stand yield curves as recommended by the Ministry of Forests, Research Branch, as no local values are available. A study by the Regional Forest Pathologist shows that stem rusts (comandra blister rust, stalactiform blister rust and western gall rust) reduce yields in pure pine stands (i.e., greater than 80% pine) by 7%. The Prince Rupert Forest Region staff believe, however, that OAF1 may be overestimated in pine analysis units, and this may partially offset the yield reduction caused by stem rusts. Therefore, the Regional Forest Pathologist recommended that OAF1 for pine analysis units be increased from 15% to 20% for stands with a pine component of at least 80% (105/205/305 to 110/210/310).

No thinning is expected based on the initial density values. The density of 2800 stems/hectare is based on the results of local field surveys. It accounts for planting density of 1400 to 1600 plus ingress which is controlled to an average of 2800 stems/hectare.

All values in Table A-13a. are based on current performance as estimated by the Lakes Forest District staff.

Analysis units 205-210 and 305-310 correspond to analysis units 105-110, but are used for site index adjustments that apply in some areas (Table A-13b.). Regeneration assumptions for analysis units 205-210 and 305-310 are the same as for the corresponding analysis units 105-110. Areas in analysis units 101-110, 205-210 and 305-310 remains in the same analysis unit upon regeneration. Site indices for secondary species were converted from the site index of the primary species using SiteTools, a computer program developed by the Ministry of Forests, Research Branch.

The area-weighted mean site index for each existing natural stand analysis unit (i.e., 1-10) is used to generate timber yield tables for the corresponding regenerated analysis unit (i.e., 101-110). In areas where site index adjustments are available, existing pine analysis units 5-10 (see discussion below), they are regenerated to corresponding analysis units 205-210 (sub-boreal spruce (SBS) mc2 biogeoclimatic unit) or to analysis units 305-310 (SBS dk biogeoclimatic unit). Where existing pine analysis units are not subject to a site index adjustment, they are regenerated to the corresponding 105-110 analysis units. Table A-13b. shows the site indices used to generate timber yield tables for regenerated analysis units. This includes corrections to account for the new regeneration assumptions for analysis units 102-104 under the *LRMP*, described above.

A.4 Current Forest Management Assumptions

Table A-13b. Site index for regenerated analysis units

Analysis unit	Species	Biogeoclimatic variant	Location	Site index (m @ 50 years)
101	F, B	All	Everywhere	11.8
102	S	All	Within special management areas	19.6
103	S	All	Within special management areas	14.9
104	S	All	Within special management areas	9.9
105	Pl	All	Within special management areas	19.2
106	Pl	All	Within special management areas	14.9
107	Pl	All	Within special management areas	11.5
108	Pl with F/S	All	Within special management areas	19.2
109	Pl with F/S	All	Within special management areas	15.0
110	Pl with F/S	All	Within special management areas	11.6
205	Pl	SBS mc2	Outside special management areas	20.0
206	Pl	SBS mc2	Outside special management areas	20.0
207	Pl	SBS mc2	Outside special management areas	20.0
208	Pl with F/S	SBS mc2	Outside special management areas	20.0
209	Pl with F/S	SBS mc2	Outside special management areas	20.0
210	Pl with F/S	SBS mc2	Outside special management areas	20.0
305	Pl	SBS dk	Outside special management areas	21.8
306	Pl	SBS dk	Outside special management areas	20.1
307	Pl	SBS dk	Outside special management areas	18.8
308	Pl with F/S	SBS dk	Outside special management areas	21.8
309	Pl with F/S	SBS dk	Outside special management areas	20.1
310	Pl with F/S	SBS dk	Outside special management areas	18.8

Note: The site indices shown for analysis units 101-110 have received no adjustments.

A.4 Current Forest Management Assumptions

As discussed in the chief forester's 1996 AAC rationale report, a paired-plot study undertaken in the Lakes TSA has provided scientifically derived, statistically reliable estimates of site productivity for this TSA, confirming the site index underestimation for managed lodgepole pine stands in this area. The results of this study — *The Effects of Stocking on Estimated Site index in the Morice, Lakes and Vanderhoof Timber Supply Areas in Central British Columbia* by James W. Goudie, 1996 — were used to adjust the area-weighted mean site index for regenerated pine analysis units within the SBS biogeoclimatic subzone. However, site index was not adjusted within the following special management areas: very high value components of the Caribou Migration Corridor, Backcountry Lakes, Stronglinks and Retention VQOs. These areas have restrictive forest cover requirements and regenerated stands are not expected to achieve the paired-plot site index. Site index adjustments use the following equations:

SBS mc2: $MSI = NSI + 20.157 - 1.007*NSI = 20.157 - 0.007*NSI$

SBS dk: $MSI = NSI + 14.243 - 0.606*NSI = 14.243 + 0.394*NSI$

where: MSI is managed stand site index

NSI is natural stand site index

The site index adjustments will be applied to both the pine and spruce components of the regenerated analysis units for deriving timber yield tables.

Tables A-13a. and A-13b. show the complete range of analysis units that occur as a result of the various regeneration activities in the Lakes TSA. However, regenerated analysis units 205, 206 and 207 have the same site index and species composition, so they are collapsed into one analysis unit (205) in the timber supply model. Similarly, analysis units 208, 209, and 210 are collapsed into analysis unit 208. The following pairs of analysis units were combined because they were very similar: 205 and 306; 305 and 308; and 307 and 310. The original data package defined analysis units 202-204 and 302-304. Since these analysis units were not used (see Section A.4.4, "Minimum harvestable ages"), they were removed from Tables A-13a. and A-13b.

A.4.9 Immature plantation history

This section identifies areas of existing immature forest where the density (stems per hectare) has been controlled justifying assignment of these stands to managed stand yield tables (MSYTs).

Table A-14. Immature plantation history

Analysis unit	Area managed (%)			
	Age 1 – 10	Age 11 – 20	Age 21 – 30	Age 31 – 40
All analysis units	100	100	100	100

Data source and comments:

Stands younger than 41 years were considered to be managed and were assigned to analysis units 101-110. Any young pine stands considered to be managed were assigned to analysis units 205-210 or 305-310 where a site index adjustment is warranted, as previously described in Section A.4.8, "Regeneration assumptions in managed stands."

A.4 Current Forest Management Assumptions

A.4.10 Not satisfactorily restocked (NSR) areas

Land classified in the Lakes TSA forest cover inventory as projected type identity 4 or 9 were included in the current timber harvesting land base. These type identities indicate not satisfactorily restocked land base. Table A-15. identifies the total area of NSR currently existing in the timber harvesting land base, and the estimated rate at which the NSR area will be restocked.

Table A-15. Not satisfactorily restocked (NSR) areas

Analysis unit	Inventory NSR (hectares)	Total NSR after deducting NCC[a] (hectares)	Current NSR (silviculture file — includes backlog) (hectares)	NSR restocking (hectares restocked, years from now)		
				Restocked	1-10 years	11-20 years
101	426	403	326	77	326	—
103	1 899	1 795	1 450	345	1,450	—
106	5 944	5 617	4 537	1 080	4,537	—
109	4 651	4 395	3 551	844	3,551	—
Total	12 920	12 209	9 864	2 345	9,864	—

(a) NCC = non-commercial cover.

Data source and comments:

Total inventory NSR is distributed to analysis units (AU) using the silviculture file proportions.

Current NSR is defined as areas not planted by the end of the 1997 planting season.

Total current NSR includes 606 hectares of backlog.

The total current NSR includes all harvesting that occurred during the 1996 cut control year. During that year harvests were higher then normal.

Most 1996 blocks have been planted but are not surveyed.

The Lakes Forest District staff believe that approximately 14% of the NSR is actually non-productive brush which is misclassified. This is reflected in Table A-15. (NCC column).

Hectares of NSR restocked equals inventory NSR after accounting for non-productive brush minus current NSR from the silviculture file.

NSR area to be restocked are assigned to regenerated analysis units 101-110 having medium productivity (e.g., spruce NSR will be regenerated to analysis unit 103). Where pine NSR is located in an area subject to a site index adjustment, it will be assigned to the corresponding analysis unit 206/306 or 209/309. Table A-15. represents all NSR in the Lakes TSA, both within and outside the timber harvesting land base. It is assumed that all NSR area will be restocked regardless of whether it is inside or outside of the timber harvesting land base, but only area inside the timber harvesting land base will be available for future harvesting.

The values in Table A-15. are slightly different from the data package as a result of errors detected by Forest District staff.

A.4 Current Forest Management Assumptions

A.4.11 Forest cover requirements — VQOs and habitat

Table A-16a. Forest cover requirements — VQOs and habitat

Resource emphasis	Maximum allowable disturbance (% area)	Green-up height (metres) / age (years)	Minimum retained area (%)	Minimum age for retention (years)	Land base to which constraints apply
VQOs					
— Significant visual retention	3.4	5 m / 28 yrs			Crown forested area for all VQOs
— Visual retention	2.3	4 m / 23 yrs			
— Significant visual partial retention	12.6	4 m / 22 yrs			
— Visual partial retention	10.7	3 m / 18 yrs			
Caribou migration corridor — very high value	2	5 m / 29 yrs			Timber harvesting land base
Caribou migration corridor — **very high and** high value	25	40 years	40 60	141 81	Crown forested area Crown forested area Crown forested area
Caribou migration corridor — moderate value	40	40 years	30 45	141 81	Crown forested area Crown forested area Crown Forested area
High value winter habitat — Moose and deer (thermal and forage)	33	3 m / 17 yrs	30	101	Timber harvesting land base Crown forested area
— Deer (very high)	25	5 m / 27 yrs	50	101	Timber harvesting land base Crown forested area
Recreation areas	7.5	5 m / 27yrs			Crown forested area
Backcountry lakes	2	7 m / 38 yrs			Crown forested area
Grizzly areas	33	5 m / 28 yrs	50	121	Timber harvesting land base Crown forested area
Integrated resource management	33	3 m / 17 yrs			Timber harvesting land base
Landscape-level biodiversity	Forest cover requirements for all seral stages (i.e., old, old+mature, early) to be applied as recommended in the *Biodiversity Guidebook*				Crown forested area

Data source and comments:

Since the *LRMP* has been approved, Table A-16a. shows all of the forest cover requirements required by the *LRMP* or interpreted from the *LRMP* document. The original data package showed the *LRMP* requirements in a separate table.

These requirements were applied to each resource emphasis group within each landscape unit with the following exception: only six hectares of the moderate value caribou migration corridor occurs outside of the Chelaslie landscape unit, so these requirements were applied to the aggregate area, not by landscape unit.

There is some overlap between caribou habitat and moose/deer habitat. Wherever this occurs, the requirements of caribou were applied; i.e., moose/deer requirements will only be applied outside of caribou habitat areas.

Under "Land base to which constraints apply," Crown forested refers to all Crown land, including ownerships 61N (UREP=use, recreation and enjoyment of the public), 62N (timber agreement land), 62C (provincial forest), 63N (provincial park), and 69C/N (miscellaneous reserves).

The average time required for stands to reach green-up height was estimated by the following method:

- determine the regenerated analysis unit for all existing stands;
- estimate the green-up age for each regenerated analysis unit using SiteTools;
- calculate the area-weighted mean of the green-up age for each resource emphasis group.

Green-up ages do not include regeneration delay, which is accounted for separately within the timber supply model. Green-up requirements that only specify an age indicate a desired seral stage distribution, not a green-up requirement for adjacency.

Visual quality — District objectives for visual quality have been communicated to major licensees and SBFEP. Review of current development plans is conducted consistent with the existing inventory and established or recommended visual quality and green-up objectives. Green-up heights were derived using the *Lakes District Visual Landscape Management Strategy* and are based on an average district slope of 25%. The maximum allowable disturbance values for VQOs are listed in Table A-16b.

Table A-16b. Calculation of maximum allowable disturbance in VQOs

VQO	Low VAC[a]		Medium VAC		High VAC		Maximum allowable disturbance (%)
	% area	% disturb	% area	% disturb	% area	% disturb	
Significant[b] visual retention	40.4	2.0	28.0	3.5	31.6	5.0	3.4
Visual retention	82.2	2.0	15.4	3.5	2.4	5.0	2.3
Significant visual partial retention	21.1	10.0	55.1	12.5	23.8	15.0	12.6
Visual partial retention	77.0	10.0	16.9	12.5	6.1	15.0	10.7

(a) VAC= visual absorption capacity.

(b) "Significant" visual quality objectives have been approved by the forest district manager and represent current management, while others not labelled as significant have been recommended by the *LRMP* table.

Data source and comments:

The maximum allowable disturbance values were applied to the entire forested land base, so no adjustment was required for the green: operable ratio. No adjustment was required for dispersion of operable and non-operable forest because visual absorption capacity (VAC) accounts for dispersion.

Caribou migration corridor — These requirements reflect current practice as documented in the chief forester's *1996 AAC rationale for the Lakes TSA* (page 31). The forest cover requirement for the very high value caribou migration corridor is to allow for mountain pine beetle salvage.

A.4 Current Forest Management Assumptions

Backcountry lakes — identified as requiring special consideration in the *1993 Interim IRM Strategies and Harvesting Guidelines for the Lakes Forest District (IIRMS)*. Backcountry lake boundaries and objectives for a non-roaded backcountry experience are reflected in current development plans. As in TSR 1, a forest cover requirement that meets a retention VQO will be applied to these areas. There are no current or planned harvesting activities in these areas. It is expected that some harvesting activities would potentially occur in these areas to deal with forest health issues.

There is an overlap between one backcountry lake and one recreation area. Since the forest cover requirements for backcountry lakes are more restrictive than for recreation areas, only the requirements for backcountry lakes will apply to the overlap.

Moose and deer winter range — Current practices are guided by requirements to maintain adequate hiding cover, thermal cover and forage (no significant change from TSR I)

Very high value deer winter range — Current practices are guided by requirements to maintain adequate hiding cover, thermal cover and forage.

Grizzly areas — The importance of the Klaytunkut and Sutherland valleys to grizzly bear was first recognized in the Klaytunkut and Sutherland LRUPs developed between 1988 and 1990. Development plan review considerations relate to controlling access and retaining sufficient old forest adjacent to valley feeding areas.

Integrated resource management (IRM) — This requirement is for cutblock adjacency.

Requirements for landscape-level biodiversity will be applied to each biogeoclimatic variant within a landscape unit, using the recommended biodiversity emphasis option (BEO) for the landscape unit. The *LRMP* recommendations on landscape-level biodiversity preceded the current policy on implementing these requirements, so the *LRMP* addresses all seral stages and does not contemplate a phase-in of the old-seral requirements in landscape units with a low BEO.

A.4.12 Forest cover requirements — landscape-level biodiversity

Landscape units have not yet been formally established. Draft landscape units are used for this analysis to represent application and evaluation of biodiversity objectives in a balanced fashion across the TSA. Seral stage forest cover requirements are specified by biogeoclimatic variant within each landscape unit and are applied to the Crown forest land base. The seral stage requirements are listed in Table A-17a. and the draft biodiversity emphasis options for each draft landscape unit are show in Table A-17b.

Table A-17a. Seral stage requirements by biogeoclimatic variant.

			Old seral requirement		Mature+old seral requirement		Early seral requirement	
Biogeoclimatic variant	NDT[a]	BEO[b]	Minimum area (%)	Age (years)	Minimum area (%)	Age (years)	Maximum area (%)	Age (years)
ESSF mc	2	Low	9		14		—	
ESSF mv1		Intermediate	9	> 250	28	> 120	36	< 40
ESSF mv2		High	13		42		27	
ESSF mv3								
SBPS mc	3	Low	7		8		—	
		Intermediate	7	> 140	17	> 100	66	< 40
		High	10		25		50	
SBS dk	3	Low	14		14		—	
SBS dw3		Intermediate	14	> 140	26	> 100	54	< 40
SBS mc2		High	21		39		40	
SBS mc3								
SBS wk3								

(a) NDT = Natural disturbance type.
(b) BEO = Biodiversity emphasis option.

Table A-17b. Draft biodiversity emphasis options by draft landscape unit

Landscape unit	Biodiversity emphasis option
Babine East	Intermediate
Babine West	Low
Bulkley	Intermediate
Burns Lake East	Low
Burns Lake West	Low
Chelaslie	High
Cheslatta	Intermediate
Fleming	Intermediate
Francois East	Low
Francois West	Intermediate
Intata	Intermediate
Ootsa	Intermediate
Taltapin	Low
Tetachuk Entiako	High

A.4.13 Wildlife trees (WT) and tree patches (WTP)

The *Biodiversity Guidebook* describes two methods for maintaining stand structure over time: wildlife trees and wildlife tree patches. Under different silvicultural systems the planned persistence of WTs and WTPs may vary; for example, in partial cutting systems, the trees that are retained may be planned for harvest at later date. Therefore, in estimating the effects of WTs and WTPs, consideration should be given to whether the trees will ever be harvested. In addition, the contribution of riparian management areas to WT and WTP requirements should be considered. Table A-18. summarizes how WTs and WTPs will be represented in the analysis.

Table A-18. Volume reductions to reflect retention of wildlife tree patches in cutblocks

Management zone	Analysis unit	Persistence	Per cent (%) recommended in applicable guidebook	Residual area estimate on the timber harvesting land base (%)
IRM	All	Long term	6	2

Data source and comments:

WTP requirements were assessed for all landscape units and BEC subzones in 1997. This analysis revealed that based on *Biodiversity Guidebook* criteria (Table 20(a), page 65 of the *Guidebook*), the district average WTP requirement (where landscape units have been established) is 6.01%.

A.4 Current Forest Management Assumptions

The Lakes Forest District staff estimated that about two-thirds of WTPs would be accounted for from forest outside the timber harvesting land base (e.g., riparian management area, inoperable forest, etc.). The remaining one-third of WTPs was treated as a reduction to timber yield curves. The area of WTPs did not contribute to old seral requirements because less than 8% of all WTPs have been assessed to be larger than two hectares. The WTP reduction was applied to the integrated resource management (IRM) zone only, as forest district staff felt that only these areas require some specific management actions to retain stand structure. The reduction to timber yields was accomplished by creating two yield curves for each analysis unit — one for the IRM zone and one for all other zones — and applying the reduction only to the curves for the IRM zone. It was assumed that wildlife tree patches will not be economical to harvest at a later date, nor will they be available for harvest during subsequent harvesting of the stand.

A.5 Volume Estimates for Existing Stands

The variable density yield prediction (VDYP) model, version 6.4a developed and supported by the B.C. Ministry of Forests, Resources Inventory Branch, was used to estimate timber volumes for existing natural stands. Table A-19. shows the volume estimates by analysis unit for existing natural stands. Fir refers to Douglas-fir.

Table A-19. Timber volume tables for existing natural stands (cubic metres per hectare)

Table	1	401	2	3	403	4	404
Species group	Fir/Balsam 0-140 years	Fir/Balsam 141+ years	Spruce	Spruce 0-140 years	Spruce 141+ years	Spruce 0-140 years	Spruce 141+ years
Site productivity	All sites	All sites	G	M	M	P	P
Age							
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0
40	5	1	18	1	0	0	0
50	18	5	77	19	6	1	0
60	39	17	133	61	35	5	2
70	66	37	184	105	76	26	6
80	89	56	228	145	114	55	16
90	110	74	266	181	149	85	31
100	130	91	299	214	180	114	50
110	148	106	328	243	209	141	71
120	165	121	353	269	235	167	92
130	182	135	376	294	259	191	112
140	198	149	394	314	280	212	131
150	213	162	409	332	298	231	149
160	227	175	422	346	314	248	165
170	240	186	432	359	327	264	181
180	252	197	440	369	338	277	195
190	263	208	446	377	348	289	209
200	275	218	453	386	357	300	222
210	285	228	459	393	366	310	234
220	296	238	464	401	374	320	245
230	306	247	469	407	381	329	255
240	316	256	474	413	387	338	265
250	325	264	478	418	393	346	275
260	327	266	481	423	398	352	281
270	329	268	484	427	403	358	287
280	331	270	487	431	407	363	293
290	333	272	489	434	411	368	299
300	334	273	491	437	415	373	304
310	336	275	493	440	418	377	308
320	337	276	494	443	421	381	313
330	339	277	496	445	423	384	317
340	340	279	497	447	425	388	320
350	341	280	498	449	427	390	324

(continued)

A.5 Volume Estimates for Existing Stands

Table A-19. Timber volume tables for existing natural stands (cubic metres per hectare) (concluded)

Table	5	6	7	8	9	10
Species group	Pure Pine	Pure Pine	Pure Pine	Pine with Fir/Spruce	Pine with Fir/Spruce	Pine with Fir/Spruce
Site productivity	G	M	P	G	M	P
Age						
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	23	1	0	20	1	0
40	80	26	0	75	26	1
50	130	66	13	123	65	12
60	175	103	41	164	100	40
70	215	136	66	201	131	65
80	251	167	91	232	159	89
90	284	195	114	260	185	110
100	314	222	136	286	208	130
110	341	246	156	308	229	148
120	367	270	176	329	248	165
130	391	291	194	348	266	182
140	407	306	208	362	279	194
150	419	318	218	372	290	204
160	427	326	226	380	297	212
170	432	331	232	384	303	218
180	433	333	234	387	306	222
190	430	332	234	386	306	223
200	432	334	237	389	309	227
210	434	337	240	391	312	230
220	437	339	243	394	315	234
230	440	342	246	397	318	237
240	442	345	248	399	321	240
250	445	347	250	402	324	243
260	447	349	253	404	326	245
270	450	351	255	406	328	247
280	452	353	256	408	330	249
290	454	355	258	410	332	250
300	455	356	259	411	333	252
310	457	358	260	413	334	253
320	458	359	261	414	336	254
330	460	360	262	415	337	255
340	461	361	263	416	338	256
350	462	361	263	417	339	257

A.6 Volume Estimates for Regenerated Stands

WinTIPSY (Windows™ version of the Table Interpolation Program for Stand Yields) version 1.4, supported by the B.C. Ministry of Forests, Research Branch, was used to estimate growth and yield for existing and future managed stands. Inputs to TIPSY, including site index adjustments, are documented in Section A.4.8, "Regeneration assumptions in managed stands" and Tables A-13a, and A-13b. Section A.4.9, "Immature plantation history" and Table A-14. document which stands are assumed to be managed in the analysis.

Table A-20. displays the volume tables for managed stands. Volumes are assumed to remain constant after 300 years of age. For some tables there was insufficient growth and yield information to model to 300 years of age — data to maximum ages are presented and the maximum volume is carried forward to 300 years of age.

Table A-20. Timber volume tables for managed stands (cubic metres per hectare)

Table	101	102	103	104	105	106	107
Species group	Fir/Balsam	Spruce converted to pine	Spruce converted to pine	Spruce converted to pine	Pure pine no SI adjustment	Pure pine no SI adjustment	Pure pine no SI adjustment
Site productivity	All sites	G	M	P	G	M	M
Age							
10	0	0	0	0	0	0	0
20	0	2	0	0	1	0	0
30	0	36	7	0	44	5	0
40	0	112	36	3	118	42	5
50	0	187	87	15	173	89	28
60	6	261	137	33	230	130	54
70	25	316	185	60	273	161	86
80	54	361	231	94	305	190	114
90	91	389	270	123	329	221	133
100	130	409	303	151	347	246	151
110	163	424	330	177	362	264	166
120	194	437	349	199	373	280	180
130	224	449	363	220	382	291	196
140	250	458	374	240	390	302	210
150	270	464	382	259	398	311	223
160	288	464	390	277	405	317	233
170	303	464	397	291	411	323	240
180	316	464	404	301	417	327	247
190	327	464	407	310	417	332	253
200	337	464	410	316	417	336	259
210	345	464	412	322	417	339	264
220	353	464	414	327	417	340	267
230	360	464	414	331	417	341	270
240	367	464	415	334	417	341	272
250	372	464	415	337	417	342	274
260	376	464	415	339	417	342	276
270	380	464	415	342	417	343	278
280	384	464	413	344	417	344	280
290	388	464	411	346	417	344	282
300	390	464	410	347	417	344	283

(continued)

A.6 Volume Estimates for Regenerated Stands

Table A-20. Timber volume tables for managed stands (cubic metres per hectare) (concluded)

Table	108	109	110	205	208	305	307	309
Species group	Pine with spruce	Pine with spruce	Pine with spruce	Pure pine SBS mc2 SI adjustment	Pine with spruce SBS mc2 SI adjustment	Pure pine SBS dk SI adjustment	Pine with spruce SBS dk SI adjustment	Pine with spruce SBS dk SI adjustment
Site productivity	G	M	P	All sites[a,c]	All sites[b,c]	G[c]	P[c]	M
Age								
10	0	0	0	0	0	0	0	0
20	1	0	0	2	2	5	1	2
30	35	4	0	53	43	80	39	44
40	104	35	4	131	117	162	112	119
50	164	79	24	189	181	238	165	184
60	226	123	47	251	247	293	219	249
70	273	160	79	292	294	332	263	296
80	311	195	109	323	330	361	296	333
90	339	229	133	346	355	381	321	357
100	358	256	155	364	373	398	339	375
110	373	279	175	377	387	415	354	389
120	384	297	193	388	399	430	365	401
130	394	310	212	399	410	430	374	412
140	402	321	229	409	419	430	382	421
150	410	330	245	417	426	430	389	428
160	416	337	256	417	426	430	396	428
170	421	343	265	417	426	430	402	428
180	425	348	273	417	426	430	407	428
190	425	353	280	417	426	430	412	428
200	425	357	286	417	426	430	412	428
210	425	359	290	417	426	430	412	428
220	425	360	293	417	426	430	412	428
230	425	362	296	417	426	430	412	428
240	425	362	299	417	426	430	412	428
250	425	362	302	417	426	430	412	428
260	425	363	304	417	426	430	412	428
270	425	363	306	417	426	430	412	428
280	425	363	308	417	426	430	412	428
290	425	363	310	417	426	430	412	428
300	425	363	311	417	426	430	412	428

(a) Analysis units 205, 206 and 207 have the same site index and species composition, so they are collapsed into analysis unit 205.

(b) Analysis units 208, 209, and 210 have the same site index and species composition, so they are collapsed into analysis unit 208.

(c) The following pairs of analysis units were combined because they were very similar: 306 with 205; 308 with 305; and 310 with 307.

Appendix B

Socio-Economic Analysis Background Information

B.1 Limitations of Economic Analysis

The socio-economic analysis portion of this report identifies employment and income impacts, changes in government revenues, and community impacts as a result of changes in the TSA's harvest levels over time. Some of the assumptions used in this report are as follows:

- **Employment multiplier** — employment multipliers are used to estimate indirect and induced employment impacts of a change in direct industry activity. The calculation of employment multipliers is based on analytical assumptions and data collected at a specific time period. The multipliers reflect industry and employment conditions at that time and may not accurately reflect industry and employment conditions in the future.

- **Employment coefficient** — employment coefficients are ratios of person-years of employment per 1000 cubic metres of timber harvested. These ratios are used to estimate employment levels associated with alternative harvest rates. This method of analysis assumes that the industry structure will be the same in the future as it is today. While reasonably accurate in the short term, employment coefficients may change in the future due to changes in market conditions, product mix or production technologies.

- **Timing of impacts** — employment impacts are shown to occur simultaneously with a change in the harvest level. While this assumption is reasonably accurate for the harvesting sub-sector, employment estimates for the silviculture and timber processing sub-sectors may not be as coincidental. As well, indirect and induced impacts tend to occur over a longer period, as levels of business and consumer spending adjust to changes in harvest levels.

- **Operating thresholds of mills** — it is unlikely that impacts on timber processing employment due to changes in harvest levels will be in direct proportion to the harvest changes (i.e., a 10% change in harvest may not lead to a 10% change in timber processing employment). Impacts on timber processing employment are more likely to occur step-wise related to operating thresholds of mills. For example, if a mill's timber supply is reduced, its operating threshold is reached when the decrease in timber supply causes it to lay off a shift of workers or to close the mill, either temporarily or permanently. Conversely, if the timber supply to the mill is increased, a processing threshold is reached when the mill has to decide whether to add another shift of workers or new capacity to process the increase in timber supply. In both cases, the per cent change in employment in the mill would probably differ from the per cent change in the timber processed. Because mills have many different operating configurations, accurately predicting an individual mill's operating threshold is impossible. As a result, impact figures pertaining to employment in timber processing are best interpreted as size of change rather than as precise changes in employment levels.

- **Government expenditures** — provincial government expenditures are more related to government policy and population levels than to industry activity. As such, expenditures on education, health care and other government services are assumed to remain unchanged despite changes to the harvest level and subsequent changes in government revenues from the forestry sector. However, provincial government expenditures would likely change if a community's population significantly changes. This would amplify the community impacts of losses or gains in forestry sector jobs.

- **Proportional harvest reductions** — harvest reductions are assumed to be proportionately distributed among all licensees and all forms of tenure within the TSA.

B.2 Economic Impact Analysis Methodology

Data sources

Data for the socio-economic analysis were obtained from several sources. Harvest volume and stumpage data are from the Ministry of Forests. Timber flow and employment data are from responses to questionnaires that were sent to licensees, operators and processing facilities in the TSA. Other general economic data are from BC STATS, the Ministry of Finance and Corporate Relations, Statistics Canada and local communities. Estimates of taxes paid by the forest industry are from PriceWaterhouseCoopers.

Person-year of employment

The unit of measurement for employment is a person-year. A person-year of employment is defined as a full-time job, which lasts at least 180 days per year. Part-time jobs were converted to equivalent full-time person-years of employment.

To estimate employment and income impacts associated with changes in TSA timber harvest levels, the forestry sector was divided into three sub-sectors:

1) harvesting;
2) silviculture; and
3) timber processing.

Employment and income impacts were estimated in several steps. The first step was to assess current activity in each of the three sub-sectors. Then, indirect and induced employment and employment income impacts were estimated, using data from Ministry of Finance and Corporate Relations (1996) and Statistics Canada. Next, employment coefficients were calculated and then applied to the base case harvest forecast. Other indicators of the forestry sector's contribution to the provincial economy, such as government revenues and industry taxes were also calculated, using Ministry of Forests stumpage estimates and other data sources.

Employment — harvesting

Direct employment in harvesting consists of all woodlands-related jobs including harvesting, log salvage, planning and administration functions and log transportation. The employment multipliers used in this analysis define activities such as road building or maintenance work as indirect employment rather than direct employment because the forestry sector and other basic sectors purchase these services.

Data on employment, place of residence and timber flows were obtained from responses to questionnaires that were sent to licensees and operators in the TSA. The information was then used to estimate employment averages associated with harvest changes and the proportion of residents *versus* non-residents who work in the TSA.

Two estimates of direct employment in harvesting were calculated:

1) TSA direct employment in harvesting consists of employees who are engaged in harvesting and related activities within the TSA and who reside in communities within the TSA; and
2) Provincial direct employment in harvesting consists of employees who are engaged in harvesting, as above, plus those workers who reside outside the TSA, but who come to the TSA to work in harvesting and harvesting-related activities.

The estimates of TSA and provincial direct employment in harvesting were used to calculate employment coefficients per 1000 cubic metres. These employment coefficients were then used to estimate harvesting employment associated with the different harvest levels in the base case forecast.

Employment — silviculture

Silviculture employment consists of all basic and intensive reforestation activities, including surveys, site preparation, planting, fertilization, pruning and spacing. Silviculture employment data were collected from the Ministry of Forests and licensees whose tenures require post-harvest silviculture work. Most silviculture work is seasonal and silviculture employees usually only work part-time during the year. Because of this, information on silviculture employment was converted into equivalent full-time person-years of employment. Respondents were also asked to estimate the percentage of their silviculture employees who resided within the TSA and outside the TSA.

As with the harvesting sub-sector, two estimates of direct employment in silviculture were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for silviculture employment in the same manner as the employment coefficients for harvest employment.

Employment — timber processing

Information about employment, production and sources of timber was gathered from mills. Information was also gathered as to whether timber harvested from the TSA was processed within the TSA or outside the TSA. This information indicates the degree of dependence the mills have on timber harvested within the TSA. To estimate the share of processing employment supported by TSA timber, mill employment was prorated by the relative contribution of timber from the TSA to a mill's total timber requirement. For example, if 80% of a plant's timber supply is from the harvest of the TSA, then 80% of the employment in the plant would be attributable to the TSA harvest. Employment figures were also adjusted to reflect the residences of workers (i.e., those who lived within the TSA and those who lived outside the TSA). Employment in timber processing that is supported by chip by-products from milling operations was also similarly estimated.

As with the harvesting sub-sector, two estimates of direct employment in timber processing were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for timber processing employment in the same manner as the employment coefficients for harvest employment.

Indirect and induced employment estimates

Indirect employment in the forestry sector refers to those who provide goods and services to firms directly engaged in the basic forestry sector (for example, those who build or maintain road for log transport). Induced employment refers to those who provide the goods and services purchased by employees who are directly and indirectly engaged in the industry (for example, those who work in retail outlets). Indirect and induced employment figures were calculated using TSA and provincial employment multipliers developed by the Ministry of Finance and Corporate Relations.

Two sets of employment multipliers were calculated for this report: a migration multiplier and a no-migration multiplier. The migration multipliers assume that displaced workers will leave the region, reducing total income in the region by their full wage. The no-migration multipliers assume that displaced workers remain in the area, at least in the short term, and unemployment and other social safety net payments temporarily offset some of the income loss. Using the no-migration multipliers diminishes the degree of induced impacts associated with a change in direct employment.

B.2 Economic Impact Analysis Methodology

The TSA and provincial employment multipliers used in the Lakes TSA analysis are shown in Table B-1.

Table B-1. Employment multipliers — Lakes TSA

Forestry sub-sector	Lakes TSA migration multiplier	Lakes TSA no-migration multiplier	Provincial (interior) migration multiplier	Provincial (interior) no-migration multiplier
Harvesting	1.23	1.39	2.14	1.80
Solid wood processing	1.25	1.47	2.29	1.93
Pulp and paper	N/A	N/A	3.02	2.48

Sources: Ministry of Finance and Corporate Relations. 1999. The 1996 Forest District Tables.

Ministry of Finance and Corporate Relations. 1996. A provincial impact estimation procedure for the British Columbia forestry sector.

Estimates of employment income

Employment income was calculated using average income estimates for workers in the forest industry. Based on Statistics Canada data, the weighted average annual pre-tax income (less benefits) for forestry sector workers during the period 1997 to 1999 (in 1999 dollars) was:

$47,400 for those working in logging and forestry services;

$46,700 for those working in solid wood manufacturing; and

$56,500 for those working in pulp and paper mills.

Those in indirect and induced occupations earned approximately $30,700. Income taxes were calculated based on marginal tax rates of 23-28% with one-third of the total income tax paid accruing to the province.

Employment estimates of alternate timber supply levels

To estimate employment generated by alternative timber supplies, the forecast harvest level is multiplied by the calculated employment coefficients. Note that employment coefficients are based on current industry productivity, harvest practices and forest management assumptions and will not likely reflect industry operating conditions in future years. Therefore, the employment estimates should be viewed as indicators of size of change rather than as precise estimates of changes in employment levels.

B.2 Economic Impact Analysis Methodology

Provincial government revenues

Except for stumpage, royalty and rents, which are specific to the TSA, provincial government revenue impacts were estimated by using industry averages. Revenues per 1000 cubic metres of harvest, expressed as dollars per 1000 cubic metres, were calculated and applied to the harvest levels in the base case forecast in a manner similar to how employment impacts were estimated (Table B-2).

Table B-2. Estimates of provincial government revenues — Lakes TSA

	Average annual revenue 1997-2000 ($ millions)	Revenue ($ per '000s m^3)
Stumpage and related payments[a]	60.8	38,000
Forest industry taxes[b]	11.9	7,500
Employee income tax[c]	9.0	5,600
Total	81.7	51,100

(a) Source: Ministry of Forests, Revenue Branch.

(b) Based on estimates by PriceWaterhouseCoopers. Includes taxes for logging, corporate income, corporate capital, sales, property and electricity.

(c) Estimated from Revenue Canada income tax rates and includes only the provincial share of income taxes paid.